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A Sun Power Plant in Philadelphia.

In our issue of May 13, 1909, we described the experiments which had been carried on for some time by two American inventors to develop power from the heat of the sun on a commercial scale.

As readers who studied that article may recall, the general scheme was to expose water to the rays of the sun in broad shallow troughs covered with glass and thereby heat it to a temperature of some 200°. This heated water was to be stored in a large insulated tank and used to develop power according to one of two plans. The first plan was to use the hot water to evaporate some volatile liquid such as ether or ammonia, the gas evolved from this liquid at high pressure being then used to develop power. The other plan was to use the hot water direct in some form of low-pressure steam turbine connected to a condenser.

Since that date the first of the inventors referred to, Mr. Frank Shuman, of Tacony, Philadelphia, has entirely revised his plans and apparatus. The accompanying cuts illustrate the new sun-power plant which Mr. Shuman has recently erected at Philadelphia.

A description of the plant and the photographs reproduced herewith have been furnished to us by Mr. Shuman, and we print the following extract from the description.

The sun-power plant in its present development consists of the absorber, a low-pressure steam engine, condenser, and auxiliaries.

The absorber, in a general way, is composed of a series of units, each containing a flat metal honey-comb water vessel rectangular in shape, and resembling closely a large waffle. This vessel is enclosed in a flat wooden box covered with two layers of glass having a one-inch air space between them, and having the under surface of the box insulated against heat loss downward by a 2-in. layer of regranulated cork and two layers of water-proofed cardboard.

The boxes are mounted on supports which elevate them some 30 ins. above the ground, and which permit them to be inclined perpendicular to the sun at the meridian. These adjustments of the inclination need only be made about once in three weeks.

Plane mirrors of cheap construction are mounted on two sides of the boxes in order that more rays of the sun may be absorbed and reflected upon the surface of the water vessel. This latter is connected at one end to a feed pipe from the water supply, and at the other end to a steam pipe. The steam pipes from the various units are connected together and empty into a main 8 ins. in diameter in the present plant, which conveys the steam to the engine.

The engine is a new type, low pressure, reciprocating steam engine of great steam economy, which will be described in detail at some future time. Connected with it is a condenser of ordinary type and auxiliaries such as may be found in any condensing plant. The water from the condenser is pumped back into the absorber, thus insuring a continuous closed circuit whose only water loss is from accidental leakage, which is carefully guarded against.

The power of this first plant is used for pumping water by means of a reciprocating steam pump of the ordinary type, and whenever the sun has shone during the past six weeks, this plant has pumped water successfully and practically. The capacity of the present plant, in this latitude, is 3,000 gallons of water per minute, lifted to a height of 33 ft.

From actual tests made in Philadelphia in August, 1911, it was found that from the absorber of 26 banks of units, each containing 22 single units and having a light absorptive area of 10,296 sq. ft., and an actual area of 5,148 sq. ft., there could be developed during eight hours 4,825 lbs. of steam. The power produced was much lower than normal to the plant, as it was built for tropical use and was entirely unfitted for commercial work in northern latitudes.

It is found by observation that the steam generated in a sun-power plant is reduced largely by humidity and the presence in the air of smoke, haze, etc. It follows, then, that the efficiency will be greatly increased when the apparatus is tested in a dry climate free from atmospheric impurities attendant upon proximity to a large city. The plant was set up at Philadelphia, not because it was considered to be a commercial thing there, but because the necessary experimenting with a new plant thousands of miles from home would have been exceedingly expensive. Within a month or two this plant will be taken down and erected in Egypt. This can be conveniently done, as the entire heat absorber is practically portable.

Again, the losses of heat by conduction and convection in northern latitudes is enormous. If the present apparatus is placed in an average air temperature of 100° F., such as obtain throughout all equatorial regions, it is safe to assume that the power will be multiplied three-fold.

Having described the mechanism of the sun-power plant, it remains to discuss the opportunities for its use. The immediate opportunities for sun power are in those regions in the tropics where the sun practically shines throughout the year, and fuel is very expensive, coal costing in some localities $30 per ton.

Mr. Shuman's present apparatus is in type quite similar to one which he constructed and

A SUN POWER PUMPING PLANT IN OPERATION AT TACONY, PHILADELPHIA, PA.
Frank Shuman, Inventor.

operated some four years ago at Philadelphia, but afterward discarded as involving too great an investment for a given power to be possible of commercial success.

From the figures given in Mr. Shuman's description above and from such information as the photographs furnish, it would seem to us that the present apparatus, notwithstanding the improvements in detail which have been made upon it, is open to the same objection.

It is stated that the apparatus produced during eight hours 4,825 lbs. of steam. As there is no storage, it is evident that this steam must have been produced chiefly during the four hours or so of intense heat near the middle of the day. If, however, the output of steam were uniform during the eight hours, the average per hour would be 603 lbs.

Now, how many pounds of this steam (which is at atmospheric pressure) would be required to produce a horsepower-hour? In view of the very low pressure of the steam, the power required to operate the air pump and other auxiliaries of the condensing apparatus and the well-known "steam eating" propensity of small reciprocating engines (we might add also in view of the massive character of the machinery as shown in the photographs) it would be surprising if a steam consumption as low as 40 lbs. per brake horsepower could be attained.

Dividing 603 by 40 we have the quotient, 15 HP., as the net average eight-hour output to be expected from the apparatus. Even if we accept Mr. Shuman's estimate that three times this power could be obtained from this plant in an arid region in the tropics where sunshine every day may be counted on, the total average output would be only 45 HP. This would be (from Mr. Shuman's figure of 10,296 sq. ft. of light absorptive area) one horsepower for each 686 sq. ft. of heat absorbing apparatus at Philadelphia, or each 229 sq. ft. in the tropics.

This is much higher than the figure obtained by Mr. Shuman's earlier tests reported by us in our issue of May 13, 1909, where he claimed that 160 sq. ft. of heat absorptive surface would collect sufficient heat to develop a horsepower.

We have no desire to throw cold water upon the scheme, for a "sun engine" would be particularly liable to have its efficiency destroyed by any cold water application, and the machine is certainly a remarkable and interesting feat in mechanical engineering and in practical thermodynamics.

We are obliged to say, however, that any attempt to make a closed steam boiler for the sun to shine on and heat—for that is what Mr. Shuman's plant amounts to—impresses us as the wrong way to attack the fascinating problem of harnessing the sun.

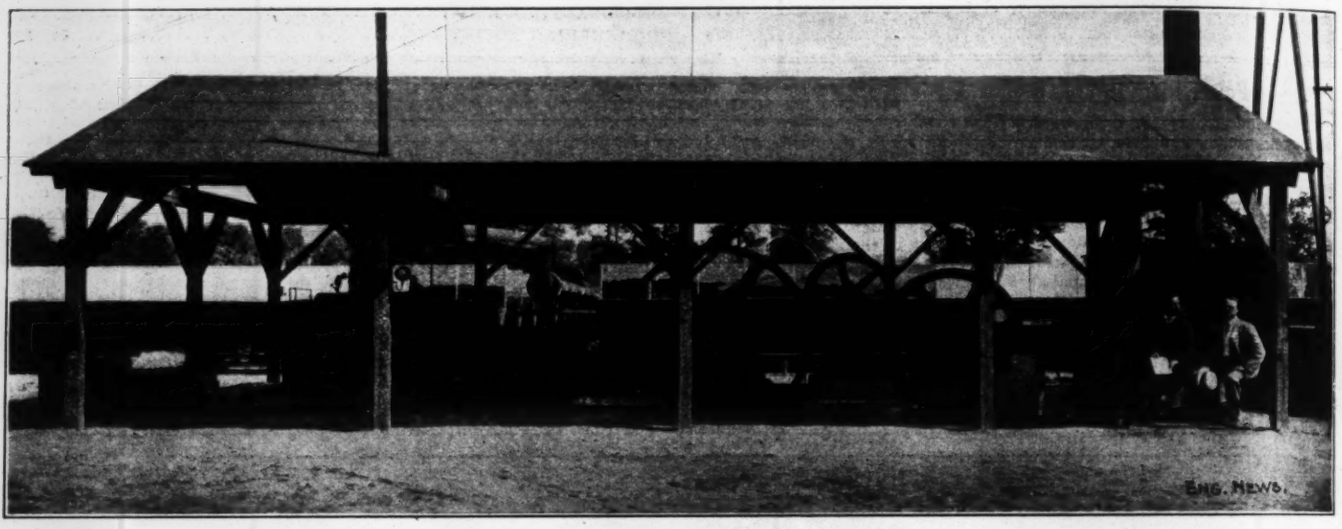
The scheme originally worked out by Mr. Willsie, and favored two years ago by Mr. Shuman himself, impresses us as much the more promising for constructing a commercial sun-power plant.

It is due to Mr. Shuman to say, however, that a great deal of time, energy and money and the services of capable engineers have been devoted by him to working out the mechanical details of his system. The engine designed for operation with steam at atmospheric pressure especially, we understand to embody some very novel features in design which we hope at a later date to be able to place on record.

He states that the Philadelphia plant illustrated is to be taken down and re-erected in Egypt for irrigation work. In fact, it is to irrigation pumping in arid regions of the tropics, particularly where fuel is very high-priced or even unavailable in considerable amounts at any price, that Mr. Shuman is now looking forward as a field where his apparatus may be made commercially applicable.

It is fair to say that Mr. Shuman claims the first cost of his heat-absorbing plant, which corresponds to the steam boiler in a steam power plant, to be not more than double that of a high-class steam boiler of equal power, and sets the cost of annual maintenance and repairs on the apparatus as low as 5%.

However, this may work out in actual practice, Mr. Shuman appears to have gone much further than any previous inventor in actually developing power in material amount from the sun's energy and on a plan giving some promise at least of practical success. As a contribution to a scientific and economic problem of great importance, his work has seemed to us deserving of record.



VIEW OF ENGINE, CONDENSER, AND AUXILIARIES OF SUN POWER PUMPING PLANT.

The North-South Subway line in Paris has recently been thrown open for traffic, and interest has been aroused by some peculiarities of the equipment. The line connects the southern quarter of Vaugirard with the northern Montmartre quarter, giving direct communication between the Montparnasse and the St. Lazare railway stations. It is a double-track tunnel of about the same dimensions as the Metropolitan tube with which there are four intersections with interchange stations where the passengers may transfer between the two railways without extra fare. At present there are 18 passenger stations, but when the rest of the subway is opened there will be 31. First and second-class cars with about 80 seats are used.

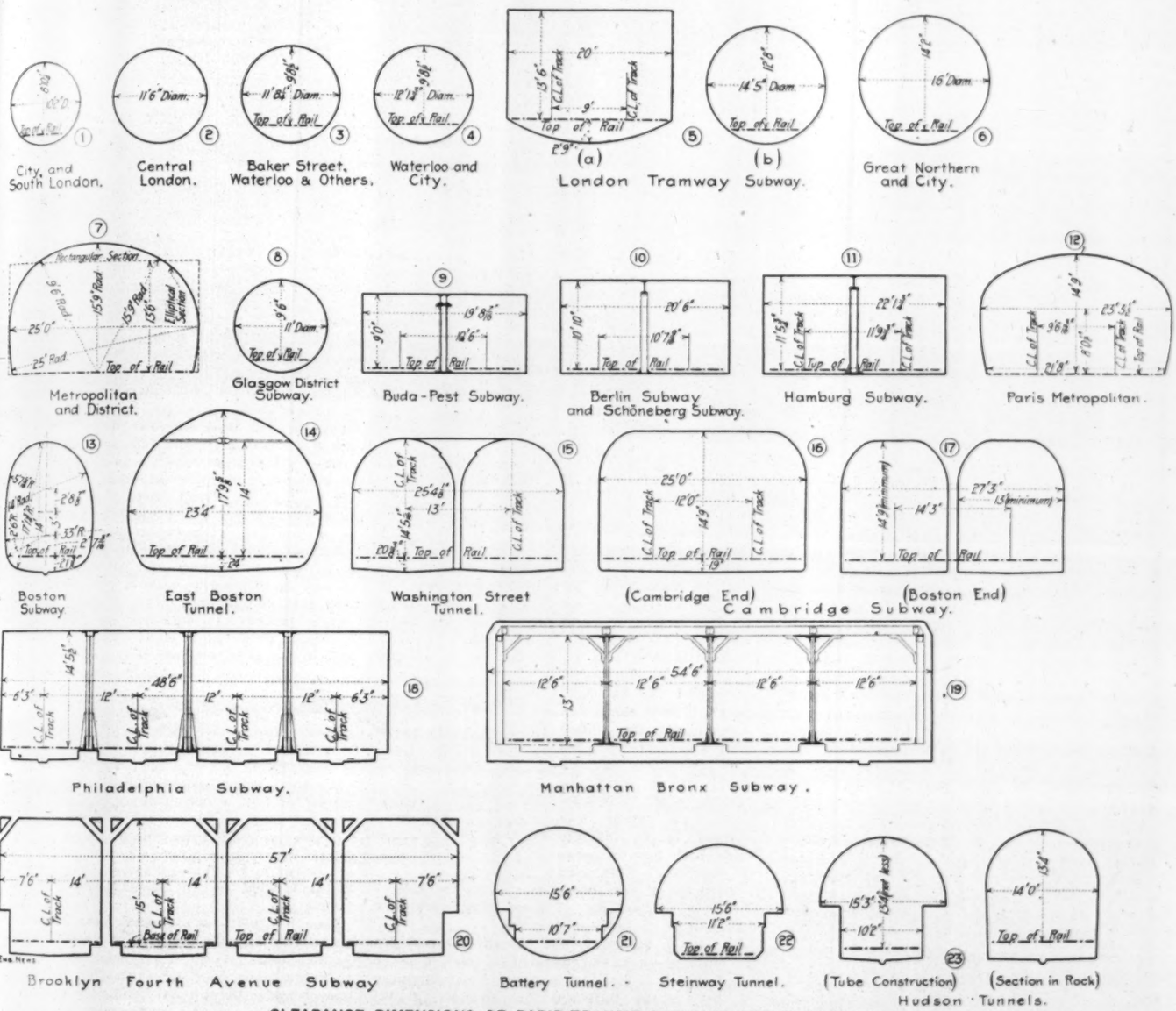
According to the London "Electrician" of Aug. 25, 1911, the motor-cars and trailers have the same general appearance of those on the Metropolitan system, although there are differences in detail. The chief point of novelty seems to lie in the use of both a third-rail and overhead trolley wire for supplying direct current to the train. The potential between third-rail and trolley is 1,200 volts, the running rails being a grounded neutral. Two motor-cars per train are used, with 600-volt equipment, one motor-car being connected between the third-rail and track and the other between the overhead line and track. The need of preserving a balance of load in the two circuits prevents the use of an uneven number of motor-cars, as on the Metropolitan line, and the capacity of the motors themselves has been increased so as to make necessary the use of only two motor-cars under all train loads. A train is made up with a motor car at each end and a variable number of trailers between. The motor cars and trailers have two bogey trucks. Each motor-car carries four 125-HP. motors. Current is received at 10,000 to 15,000 volts from suburban stations at St. Denis and Ivvy and is transformed to 1,200-volt direct current at two rotary-converter sub-stations.

Concrete Laying at Gatun Locks, on the Panama Canal, was begun on Aug. 24, 1909, and on Aug. 24, 1911, there had been placed 1,718,790 cu. yds., leaving to be placed 451,210 cu. yds. An average of 2,183 cu. yds. was laid per working day during the period Aug. 24, 1909 to Aug. 24, 1910, and an average of 2,911 cu. yds. per working day during the period Aug. 24, 1910 to Aug. 24, 1911. The work has been done by two plants, one consisting of eight 2-yd. cube mixers, whose product is placed by four duplex cableways stretching across the lock site, and the other, of two 2-yd. cube mixers, whose product is conveyed to place by construction railway. The cableway plant was not in full operation until Jan., 1910, although it began work on Aug. 24, and the second plant began mixing concrete on Dec. 27, 1909. The amount of concrete placed each month will decrease steadily from this time forth, because the floor in all three locks is completed, and the second plant, which was largely engaged on the floor work, cannot be used to full capacity much longer. The walls in the upper and middle locks are practically completed, and the placing of concrete in large quantities is now confined to the lower locks, the walls of which are rapidly nearing completion.—"Canal Record."

The Boonton Hypochlorite Plant built by the Jersey City Water Co. to treat the water-supply of Jersey City has been held by the N. J. Court of Errors and Appeals as affording compliance with the contract between the company and Jersey City as regards protecting the water-supply from pollution by certain villages on the drainage area of the Rockaway River above the reservoir. This decision affirms that of the lower court. The city maintained that the contracting company was under obligation to build sewers to divert the sewage of the villages in question to a point below the dam. See Eng. News, June 24, 1910, for article and editorial note on Boonton hypochlorite plant, and June 9, 1910, for a note (p. 686) giving the findings of the master in chancery on which findings the State Supreme Court based the decision which has just been upheld.

Clearance Dimensions of Rapid-Transit Subways and Tunnels.

An interesting series of cross-section clearance outlines of existing rapid-transit subways and tunnels is reproduced in the drawing herewith. It was compiled by Mr. Robert H. Whitten, librarian and statistician to the Public Service Commission of New York City. The smallest section of the series is the City and South London tube, with 10 ft. 2 in. inside diameter and less than 9 ft. center height above top of rail. The section of the Brooklyn Fourth Ave. subway, New York City, is the largest, with 14-ft. spacing of tracks and 14½ ft. clear height above top of rail. The extreme dimensions of the cars used are given, for most of the sections shown, in the accompanying list of notes.



CLEARANCE DIMENSIONS OF RAPID-TRANSIT SUBWAYS AND TUNNELS.

Notes to Clearance Sections of Rapid-Transit Subways and Tunnels With Car Sizes.

1. LONDON.—City & South London. Single-track deep-level tube. For later extensions the diameter was made 10 ft. 6 ins.

2. LONDON.—Central London. Single-track deep-level tube. Standard car, 8 ft. 6 ins. wide by 9 ft. 4½ ins. high over all.

3. LONDON.—Baker St. & Waterloo; Great Northern, Piccadilly & Brompton; Charing Cross & Hampstead. Single-track deep-level tubes. Standard car, 8 ft. 11½ ins. wide by 9 ft. 5⅝ ins. high over all.

4. LONDON.—Waterloo & City. Single-track deep-level tube.

5. LONDON.—Tramway subway. (a) Straight portion of shallow double-track tunnel under Kingsway. (b) One of the twin single-track tubes. Standard car, 6 ft. 10 ins. wide by 11 ft. high over all.

6. LONDON.—Great Northern & City. Built larger than other London tubes to admit cars of Great Northern Ry.

7. LONDON.—Metropolitan & District. Double-track. Standard car, 8 ft. 9¾ ins. wide by 12 ft. ¾-in. high over all.

8. GLASGOW.—District Subway, 4-ft. gage. Single-track deep-level tube.

9. BUDA-PESTH.—Subway. Double-track line with overhead trolley. Standard car, 7 ft. 2⅝ ins. wide over all.

10. BERLIN.—Hoch und Untergrund bahn and Schöneberg subway; double-track. Standard car, 7 ft. 6 9/16 ins. wide over all.

11. HAMBURG.—Stadt und Vorort bahn; double-track.

12. PARIS.—Métropolitain; double-track. Standard car, 7 ft. 10½ ins. wide by 11 ft. 2 ins. wide over all.

13. BOSTON.—Street-car subway (Sta. 0 to Sta. 23 + 40); single-track.

14. BOSTON.—East Boston tunnel (at Sta. 8 + 0); double-track. Used by surface cars only.

15. BOSTON.—Washington St. tunnel (at Sta. 51 + 50); double-track. Standard (steel) car, 8 ft. 9 ins. wide by 13 ft. 3½ ins. high over all.

16. CAMBRIDGE.—Main St. Subway (built by Boston Elevated R. R. Co.); double-track. Planned for operation of cars 10 ft. wide and 70 ft. long.

17. BOSTON.—Boston end of Cambridge Subway (built by Boston Transit Commission); double-track.

18. PHILADELPHIA.—Market St. Subway; four-track. Standard car, 8 ft. 9 ins. wide by 13 ft. high over all.

19. NEW YORK.—Elm St. Subway; four-track. Standard car, 9 ft. 6 ins. wide by 12 ft. high over all.

20. NEW YORK.—Brooklyn Fourth Ave. Subway; four-track.

21. NEW YORK.—Battery Tunnel (of Elm St. Subway extension); single-track. Standard car, 9 ft. ⅛-in. wide by 12 ft. high over all.

22. NEW YORK.—Steinway (Belmont) Tunnel; single-track.

23. NEW YORK.—Hudson & Manhattan Tunnels; single-track. Car type No. 1, 8 ft. 10⅝ ins. wide by 12 ft. high over all; Car Type No. 2, 8 ft. 11 ins. wide by 11 ft. 8 7/16 ins. high over all.

Kansas Irrigation Statistics, compiled by the Bureau of the Census, show that the total irrigated area of the state increased from 23,620 acres in 1899 to 37,479 acres in 1909, or 58.7%. The increase in area of improved farmlands for the same period was only 19.2%. The following figures relating to sources and modes of water-supply are taken from a statement issued by the Bureau of the Census:

The number of reservoirs in 1909 was 42, with a combined capacity of 31,024 acre-ft. But three flowing wells used for irrigation were reported. The number of pumped wells used for irrigation was 939, and the number of pumping plants 484. Two enterprises reported central power plants with large numbers of wells pumped. This accounts for the excess in the number of wells over the number of pumping plants. The engine capacity of pumping plants, excluding windmills, was 1,112 HP. The acreage irrigated with pumped water in 1909 was 1,979 acres. This does not include the acreage under the Garden City project of the United States Reclamation Service, which received water from both the Arkansas River and pumped wells. These wells were operated in 1908 and 1909, but have not been used since, and this land has received only river water since 1909.

A Large Cofferdam Built With Steel Sheet Piling.

Among the interesting features of the construction of the LaSalle St. tunnel, at Chicago, is the method of connecting the river section with the land approach tunnels. The tunnel was described in detail in our issues of Jan. 12 and April 13, and it may be briefly noted that the river section is a twin-tube steel shell which was sunk in place in a deep trench dredged across the bed of the river. Each end was closed by a timber bulkhead, and a timber crib or cofferdam was built above each end for connection with the shore cofferdam. A steel manhole shaft was built over the end of each tube, extending above the water level when the tunnel was in place, so as to give access to the interior for completing the concrete lining. Previous to the sinking of the tube, lines of steel sheet piling were driven at each side of the river to be connected with the timber cofferdams on the tube, and so enclosing a space which would be pumped out and excavated for the construction (in the open) of the connection between the land and river tunnels.

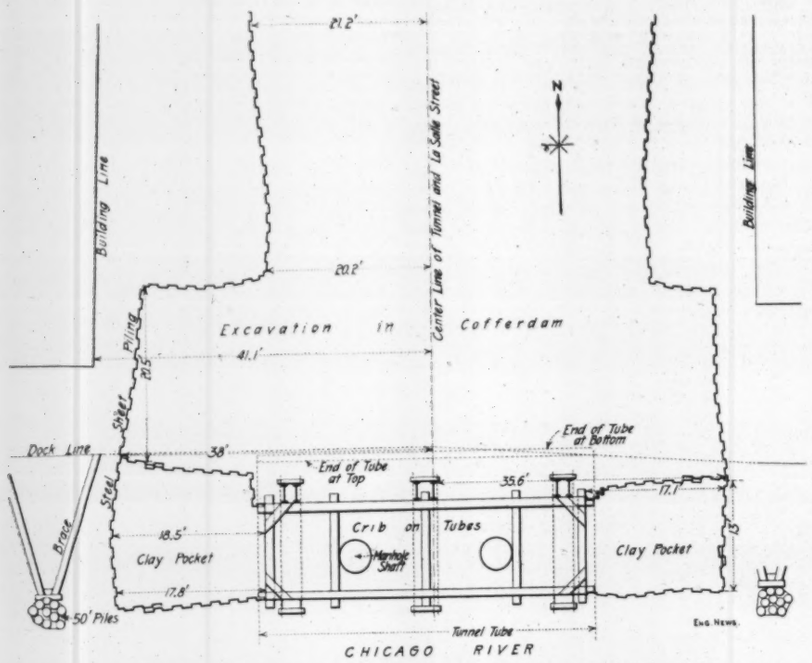


FIG. 1. PLAN OF STEEL PILE COFFERDAM AT THE NORTH END OF THE LASALLE ST. TUNNEL; CHICAGO.

A general plan of the arrangement at the north end is shown in Fig. 1. Two lines of sheeting connect each end of the timber crib with the longitudinal line of sheeting, forming chambers which were filled with clay to make a tight joint against the crib, the crib also being filled with clay. The enclosed space was then pumped out, the steel sheeting being braced by timbering in the usual way.

This cofferdam is 75 × 53 ft., with a depth of 53 ft., and about 53 ft. of water against the river side. The sides are formed of the Friestedt interlocking steel piling (Carnegie Steel Co.) in lengths of 60 and 65 ft., with a penetration of about 8 ft. in the clay bed below the tunnel invert. Each pile is a 15-in. 40-lb. channel, having two 4-in. Z-bars riveted to its web, as shown in Fig. 2. No packing was used in the interlocking joints, the fit being so close that the sheeting was practically watertight under the full head of 53 ft. of water. The bracing was of timbers 12 × 12 ins., spaced 8 ft. horizontally and 4 ft. vertically. As the water was pumped out, additional sets of bracing were placed, the timbers of each new set being suspended from the completed set above by means of rods and stirrup plates. This construction is shown in Fig. 3, which gives also a good idea of the size of the cofferdam. The timber wall at the left is the face of the timber crib.

The top of the work during construction is shown in Fig. 4, with the pile driver finishing one of the corner pockets for clay filling. In line with the two rows of steel sheeting are the timber walls of the crib, with one of the manhole shafts between them. The main body of the cofferdam is at the left. The cofferdam was pumped out by means of a 6-in. centrifugal pump and a 4-in. vacuum pump, and the latter then took care of all leakage.

The tunnel tube is approximately oval in section, and consequently two open spaces were left between the sides of the tube (at the bottom) and the vertical walls of steel piling. In addition to this the bottom of the excavation (dredged out in advance) was below the bottom of the tubes. To fill the bottom space and the two side spaces, broken stone was dumped into the cofferdam, and vertical pipes were embedded in this stone. When the filling was completed to the desired level, grout was pumped in to fill the voids and form a mass of concrete. This was allowed to set for some time before the cofferdam was pumped out. The grouting work was described in our issue of Aug. 10.

The M. H. McGovern Co. has the contract for the entire work on the tunnel. The work is under the direction of Mr. J. Z. Murphy, Chief Engineer of the Chicago Railways Co., and Mr. J. W. Harris is Division Engineer in charge of the work.

The Nepton Tunnel now being driven in the Pachuca, Mex., district will be one of the longest mining tunnels in the world. It will be over 6 mi. long when finished, and lies at a depth of about 1,400 ft. below the surface of the city of Puebla. Though started 18 yrs. ago, only about 2 mi. of the length has been finished. The tunnel is to drain the Pachuca mining district and afford an outlet for the ores of the different mines. It is being built by Gabriel Mancera, of Mexico City. An electric power-plant has been installed near the portal, to supply power to the electric drills, and the ventilating and lighting system. An electric tramway will be installed in the tunnel when the work has progressed a little farther.

A German Study of Sludge

By KENNETH ALLEN,[1] M. Am.

As the practice of purifying sewage has developed, it has been more and more recognized that the treatment and disposal of the sludge is of primary importance, and, at the same time, a most difficult question to solve.

Dr.-Ing. F. G. Spilliner, Essen-Ruhr, Germany, Chemist of the sewage works of the Emscher District, which works have recently attracted close attention of sanitary engineers, is particularly well qualified to discuss the subject. An article by him on sludge drying, contributed by a German paper, has recently been published in pamphlet form.[2] It contains much of interest to those engaged in studying the sludge question, as may be seen from the following notes abstracted from the pamphlet.[3]

It should be stated at the outset that whether used as a fertilizer (except in irrigation), for the extraction of grease, or whether it is merely burned or used for filling in land, the large percentage of water is the greatest obstacle to contend with, and for this reason, the author is justified in confining his discussion to methods of drying.

Where the wet sludge is put on the land, drying in winter is liable to be delayed on account of frost, so that, in the case of Emscher tanks, capacity should be provided to store the sludge until warm weather. In summer, if used on cultivated land, the growth of weeds may be promoted and vermin (just what kind is not stated) may become more prevalent.

It is not often profitable to extract the grease, although this is done at a few places. At Cassel, for instance, 200,000 M. (about $40,000) were spent to recover the 15% of grease in the dry sludge by benzine after filter-pressing, the residue being used as a fertilizer. The proceeds from 50 cu. m. (54.7 cu. yds.) of wet sludge were 354 M. (about $84), but this did not equal the cost of the process, which was later abandoned. In general, it may be said that if it were not for the cost of drying, there would be a profit in grease recovery where the dry sludge contains more than 15%; otherwise it does not pay.

Attempts have been made to press sludge into briquettes and recover the calorific value, but success is infrequent without the admixture of coal dust, combustible refuse or peat. Degener's lignite process, as employed at Cöpenick and Potsdam, produces a sludge favorable to this, and it has been claimed that favorable results were obtained for the General Electric Co. by Heine.

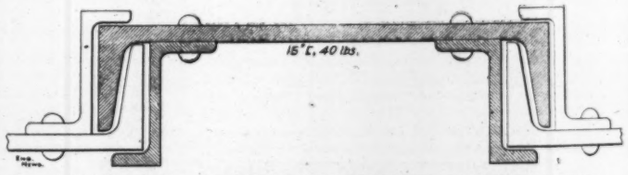


FIG. 2. SECTION OF INTERLOCKING STEEL PILING FOR THE COFFERDAM (FRIESTEDT SYSTEM).

Gas, too, may be produced from sludge, having a fair calorific power, but with little value as an illuminant; but there does not seem to be a favorable prospect for utilization in this form except under exceptional conditions.

Abandoning any idea of financial return, sludge may be burned or disposed of at sea, as at London, Salford and Manchester. (In this country, too, at Providence.) This method costs about 80 pfg. (19 cts.) per ton of wet sludge at Salford and Manchester, although the Royal Commission on Sewage Disposal gives 15 pfg. (3.6

[1] Engineer, Metropolitan Sewerage Commission, 17 Battery Place, New York City.

[2] DIE TROCKNUNG DES KLAERSCHLAMMES. —By Dr.-Ing. Friedrich G. Spilliner, Chemiker der Emschergenossenschaft zu Essen-Ruhr. Sonderabdruck aus den "Mitteilungen aus der Königlichen Prüfungsanstalt für Wasserversorgung und Abwässerbeseitigung," Heft 14, 1910. Berlin: L. Schumacher. Paper; 6 × 9 ins.; pp. 60; eight illustrations and eleven tables in text.

[3] A translation of this pamphlet, by Mr. Allen, will soon be published, together with a translation of other recent German writings on the sludge problem.—Ed.

cts.) as an [illegible]verage figure for general conditions as against [illegible]0 M. (36 cts.) for drying and burning. (11.6 [illegible] per ton at London in 1907.)

The auth[illegible] then considers burying sludge, but mentions t[illegible] difficulty in securing satisfactory results wit[illegible]resh sludge, as demonstrated by experiments [illegible] the Emschergenossenschaft, mentioning the [illegible]ct that Dr. Dunbar reported an in-

FIG. 3. INTERIOR OF COFFERDAM AT THE NORTH END OF THE LASALLE ST. TUNNEL; CHICAGO.

(The timber wall at the left is the side of the crib built upon the tunnel tube and forming the south end of the cofferdam. The darker wall at the left is the steel piling of the west side of the cofferdam.)

stance (Birmingham) where, after more than twenty years, there remained the original fecal odor.

Experience in filter-pressing, mostly in England, and with centrifugal machines, is mentioned. Both are costly, but the latter have the advantage of avoiding much manual labor and contact with the fresh sludge. At Harburg the cost is given as 3.42 M per cbm. (62.6 cts. per cu. yd.) as compared with 2.31 M per cbm. (42.3 cts. per cu. yd.) for filter pressing under similar conditions.

Fresh sludge being admittedly difficult to treat, the author takes up the subject of septic sludge. Purification of the liquid, according to Lübbert, is found to be retarded and the disturbance of the sludge by gases produced in it render the effluent turbid, and the gases themselves are offensive, as they contain so much H_2S. But the sludge, on the contrary, is in a much more favorable condition, being more concentrated, containing 20% dried material instead of 5 to 10%, as in fresh sludge. This difference is caused by the destruction of the colloidal matter. Being in a less moist and pasty condition it drains and becomes spadable much more readily. But with the objections referred to and the cost of construction, the septic tank process is meeting with less and less favor. At Birmingham—the largest plant in the world—they have reverted to plain sedimentation in spite of its disadvantages.

Turning now to the sludge from Emscher tanks, the author describes the process in considerable detail. The separation of the sludge and its storage under a considerable water pressure result in avoiding the objectionable features of the septic tank while retaining its advantages. With but 70% moisture the sludge is still mobile, flows readily and can be pumped, owing partly to the destruction of fibrous and colloidal matter and partly to the microscopic gas bubbles contained. At a temperature of 70° or 80° there is but a faint tarry odor, not noticeable at a short distance.

Careful experiments were made with Emscher sludge and are described in detail, showing that its ready drainage is a matter of great importance. Whereas fresh sludge quickly clogs the pores of the bed and then dries very slowly, Emscher sludge merely rests on the surface and drains readily; and while the water from the former is foul and putrescent, that from Emscher sludge is similar in character to the effluent from contact beds. The samples examined contained nitrites and nitrates, but were free from sulphuretted hydrogen. The moisture in the sludge was reduced by draining from 80.9% to 19.1%. The superiority of decomposed sludge with respect to drainage is attributed largely to the contained gas bubbles, which render it porous or provide drainage channels by their escape.

Examples of drying the sludge from Emscher tanks on a large scale are mentioned—such as at Recklinghausen-O, Essen—N. W. and Bochum, having an aggregate of 218,000 inhabitants, where the results have fully confirmed the anticipations.

At Essen-N. W., for instance, 72.28 cbm. of sludge was placed on a prepared bed 317 sq. m. in area to a depth of 22.8 cm., July 3, 1909. By July 6 this became spadable. It was removed July 7, when the depth measured 13.6 cbm. and the volume was reduced to 43.11 cbm.; 3.5 mm. rain had fallen July 4, 15.2 mm. July 6 and 9 mm. July 7—2.77 cbm. in all.

At Recklinghausen-O. the drained sludge is sold to farmers at 50 pfg. (12 cts.) per cartload.

On the whole, the paper is an endorsement of the process of sewage treatment devised by Dr. Ing. Imhoff, who, it should be remembered, is a colleague of Dr. Ing. Spilliner. The data on which conclusions are based, the methods of investigation and the observations are given in so much detail that there seems to be little ground for dissent from his conclusions. The separation of the sludge from the sewage adopted by Travis and Imhoff is not a new idea, but their successful application of the principle has given it great prominence. Whether the pre-eminence now enjoyed is entirely warranted or not cannot be told until the many plants now being built under different conditions have had a thorough trial. For it must be admitted that the large volume of trade wastes in the Emscher district produce a sewage that is not strictly comparable with the normal sewage of most American towns. Freedom from offensive odors and ease of drainage are valuable assets which, it would appear, may be due in large part to the pressure provided by a deep tank. If the same result can be reached without this expensive construction—as, indeed, is believed by some engineers—another step will be taken in advance.

Experiments on the Removal of Oysters from polluted to unpolluted waters is the subject of a brief article in the May number of the "Journal" of the American Public Health Association (Urbana, Ill.) The article is by Prof. Earle B. Phelps, Assoc. M. Am. Soc. C. E., New York City. Mr. Phelps concludes as the result of his experiments that surely within four days, and possibly within a shorter period of time, a healthy oyster transplanted from polluted to clean waters will rid itself of the evidences of pollution, and we may justly argue from this that the sewage material which is always associated with B. coli, and of which the latter is taken as an index, have also been eliminated.

Further experiments combined with those previously made seem to show that even less than four days in clean water would be sufficient to remove danger.

The Public Utility Commission of Nevada, acting under its new powers, has recently imposed on the public-service concerns of that state a system of uniform accounts and several general rules for the conduct of a public utility. By the Act of March 23, 1911, the old Railroad Commission was constituted the Public Utility Commission, with specific powers for the investigation of complaints, the issuing of subpoenas, the employment of experts and assistants and the establishment of reasonable rates. In imposing a specific classification of accounts, the Commission has given interested parties a chance to petition for modifications. Electricity meters are to be tested on installation and annually, or as the customer requests if not more often than once in six months. The prescribed tests are at normal load and 10% meter capacity. Normal load is defined as 40% of connected installation in the case of residence lighting and elevator service; 50% for factory and store lighting and general power service; 60% for churches, offices, theaters, clubs, restaurants, etc.; 70% for saloons, pumps, compressors and ice machines; 100% for sign and window lighting, blowers and moving picture machines. The companies supplying energy on constant-voltage systems must hold voltage constant within 6% with the possibility of demand for closer regulation in the future. All interruptions to service are to be recorded.

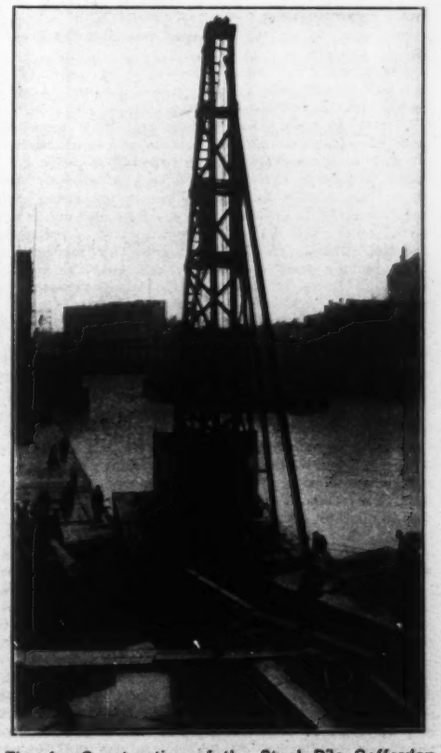


Fig. 4. Construction of the Steel Pile Cofferdam.

(The two men in front of the pile driver are standing at opposite corners of the end of the timber crib cofferdam built on the steel tunnel tube. The man between them is looking down one of the manhole shafts to the tunnel tube.)

Pumping Plant for Sewerage and Water-Works.*

By ALFRED J. PRICE.

Pumping plays so large a part in municipal engineering schemes, that despite the frequent discussion of the subject, the author trusts that the following paper may be found useful by the younger members of the Institution, and that it will not be altogether without interest to the older members.

A pump has been defined as "a hydraulic machine which gives energy to water," and this description is obviously wide enough to embrace many forms of machines not usually described as pumps, such as the hydraulic ram or the syphon. The energy may be obtained from steam, gas, oil, electricity, water or air. Pumps may be required for temporary or permanent purposes, and vary in character from the simplest form of hand pump to the large pumps driven by costly and powerful engines. Temporary pumps are required where the ground is water-logged during the laying of sewers or water mains or the construction of river and sea outfalls, sewage disposal works, water intakes, tanks, filters or reservoirs. Permanent pumps are frequently necessary at the sewage disposal works or outfalls, and sometimes at various parts of the sewerage system; and for water supplies at a pumping station built over or adjoining the well or bore hole, or near the river, stream, lake or reservoir, from which the water supply is obtained.

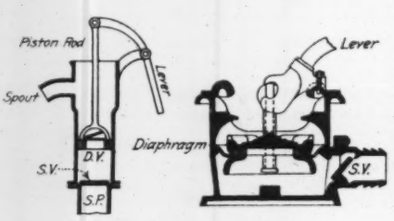


Fig. 1.

Fig. 2.

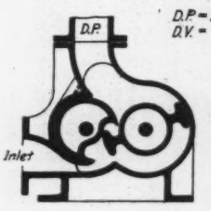


Fig. 3.

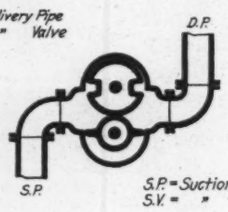


Fig. 4.

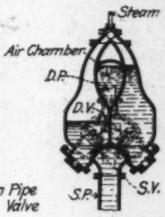


Fig. 5.

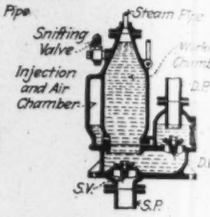


Fig. 6.

Fig. 1, Lift pump; Fig. 2, Diaphragm pump; Fig. 3, Greinel pump; Fig. 4, Drum pump; Fig. 5, Pulsometer steam pump; Fig. 6, Fluometer steam pump.

FIGS. 1 TO 6. PUMPS USED FOR TEMPORARY PUMPING.

Temporary Pumps.

The chief forms of pumps used for temporary purposes are: 1 Suction or lift pump; 2 diaphragm pump; 3 rotary pump (Greinel and Drum); 4 pulsometer pump; 5 centrifugal pump. Of these Nos. 1 and 2 are usually worked by hand, and Nos. 3, 4 and 5 by mechanical power. The centrifugal pump is largely used for temporary work, but it will be better described under permanent pumping.

LIFT PUMP.—The ordinary suction or lift pump (Fig. 1) is still largely used by small contractors for sewerage works, and frequently is the only form of pump in the possession of small local authorities. It is generally made of galvanized iron and consists of a working barrel with a suction valve at the bottom. A piston containing a delivery valve is moved up and down the barrel by means of a handle attached to the piston rod. The raising of the piston causes a partial vacuum in the barrel below, and water is forced by the atmospheric pressure through the suction valve. By raising the handle of the pump the piston falls, closes the suction valve and forces the water in the barrel through the piston valve, and when the piston is raised it acts as a bucket and lifts the water into a delivery pipe or to a spout.

Though generally of poor workmanship and limited in its power and action, it has the advantages of being cheap and portable, easily repaired and put together, and will stand a fair amount of rough usage.

DIAPHRAGM PUMP.—The diaphragm pump (Fig. 2) consists of a pump chamber containing an indiarubber diaphragm, and suction and delivery valves. As the diaphragm is deflected downwards by means of two bolts fixed to a crosshead and worked by a lever, it diminishes the volume of the pump chamber, forcing the liquid through the delivery valve. When the lever is lowered, the diaphragm expands upwards and increases the volume of the pump chamber, the delivery valve is closed, the suction valve opens and allows the liquid to rise into the pump chamber, and the liquid which had been forced through the delivery valve on the downward stroke is now lifted to or discharged through a delivery pipe or spout.

This is one of the best forms of hand pumps, though it is also made to be worked by animal or mechanical power, or hand and mechanical power combined; and may be single or double-acting. It is mainly a suction pump, as the flexible diaphragm has not the forcing power of a piston or plunger; but special forms of diaphragm suction and lift pumps are made suitable for a total suction depth and height of delivery of 35 to 40 ft. It will pump dirty or gritty water, delivers a steady continuous flow of liquid, is compact, does not easily get out of order, can be readily fitted with a new diaphragm and fixed for working and is portable and easily moved about.

ROTARY PUMP.—One of the best types of rotary pumps is the Greinel pump (Fig. 3). It is constructed with an outer casing in which are two cylindrical drums of equal diameter, nearly touching each other and revolving on parallel shafts. Along the whole length of one drum is an epicycloidal groove, and on the other are two blades or projections which alternately fit the groove. The shafts are geared together so that the grooved drum revolves twice as fast as the other. As the drums revolve one of the blades fits in the groove, the pressure in the space behind is lowered and the liquid passes into it from the suction pipe. During this time the other blade has swept the inner surface of the pump chamber, the liquid being prevented from escaping by the other blade locked in the groove of the other drum. When the two drums disengage, the liquid that has entered the pump is forced by the second blade through an opening between the two drums into the discharge pipe. The first blade sweeps the inner surface of the pump, the other engages in the groove and the process goes on again as before.

It is suitable for pumping sludge, sewage, or water containing a large amount of silt, will deliver a continuous flow, has no valves to get out of order, is compact and can be run in either direction. The working costs are, however, fairly high, it can only be used for low lifts up to 15 ft., and as it runs at a high speed there is a large amount of wear and tear on the spindles, grooves and blades.

The ordinary form of drum pump (Fig. 4) is not so efficient as the Greinel pump. It consists of two drums revolving rapidly in opposite directions. One drum has two projections which fit in two grooves on the other. As a projection makes a half revolution it arrives at the position occupied by one of the grooves, and sweeps the volume of liquid out of the pump chamber up the delivery pipe, and so on.

PULSOMETERS.—The Pulsometer pump (Fig. 5), although it has been frequently in use as a permanent pump, is chiefly used for temporary purposes. It consists of a body composed of two chambers with tapering necks bent towards each other and uniting on the top in a steam chamber in which is a ball valve. Each chamber is connected to common suction and discharge pipes, and has a suction and a delivery valve. An air chamber is connected on the suction side. The steam flows into the steam chamber and passes down the side of the neck left open by the ball having overlapped to the other seating. It presses on the liquid in the chamber, and forces it through the delivery valve into the delivery pipe. As soon as the liquid falls to the level of a horizontal opening leading to the discharge pipe the steam blows through rapidly and causes an instantaneous condensation, a vacuum forming so quickly in the chamber which has just been emptied that the ball is pulled over to the other seating. Liquid rushes up the suction pipe and fills the chamber again, while the other chamber is being emptied.

It can be used in almost all situations, requires no foundations, occupies small space, can be slung up in trenches, will work submerged, and is worked by the direct action of steam from a portable or fixed boiler, no engine being necessary. It readily pumps gritty water or sewage, although rags and paper should be screened out of the latter to prevent trouble with the valves. The pump is strong, simple and reliable in action, suitable for rough usage, nearly noiseless, and requires little attention. The capital cost is moderate, and the costs of maintenance and depreciation small. Its chief disadvantage is that the steam consumption is high, but working the steam expansively by the "Grel" arrangement effects considerable economy, although it pumps a smaller volume of liquid in the same time as an ordinary pulsometer.

Ordinary pulsometer pumps will lift to a height of 90 ft., and the high lift pump to 170 ft. Where the lift is higher than 170 ft. the pulsometers are arranged tandem, one above the other, the delivery pipe of the lower pulsometer working directly into the suction of the pump above, or discharging the liquid into a tank, from which it is lifted in the suction pipe of the pump above.

Bailey's Aqua-thruster and Evans' Fluometer are other types of pulsating pumps. In the former the ball valve is replaced by a flat plate hinged at the bottom and working between two side plates at the top.

The Fluometer steam vacuum pump (Fig. 6) differs from the pulsometer in having only one working chamber, and having no ball or other valve to control the admission of steam beyond the ordinary wheel valve on the steam pipe which regulates the amount required. It has two injector chambers, which also act as air vessels. Water is injected from these chambers through pipes into the working chamber, to assist the vacuum. Air or snifting valves, and suction and delivery valves are also provided, and the working is very similar to that of the pulsometer.

This pump is simple in construction, has no movable parts except the suction and delivery valves which are readily accessible, is certain in action, portable, and useful for excavation and foundation work.

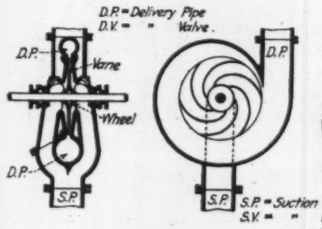


Fig. 7.

Fig. 8.

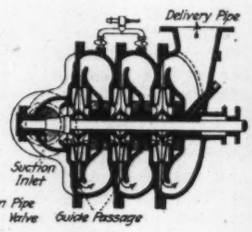


Fig. 9.

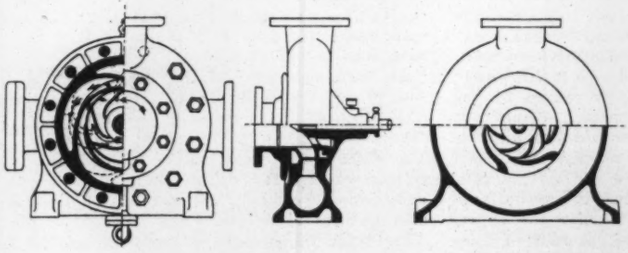


Fig. 10.

Fig. 7, Single-stage centrifugal pump; Fig. 8, Multi-stage centrifugal pump; Fig. 9, Multi-stage turbine pump for high lifts; Fig. 10, Low-lift turbine pump.

FIGS. 7 TO 10. CENTRIFUGAL AND TURBINE SEWAGE PUMPS.

*Abstract from a paper read before the Institution of Municipal and County Engineers, at the metropolitan-district meeting held at Caxton Hall, Westminster, S. W., April 21, 1911.

Permanent Sewage Pumps.

Permanent pumps for sewage may be of the following types: 1 Rotary pump; 2 pulsometer pump; 3 centrifugal pump; 4 turbine pump; 5 ram pump; 6 hydro-pneumatic ejector (Shone's); 7 vacuum pump (Liernur); 8 automatic sewage lift (Adams'); 9 hydraulic pump; 10 air lift (Caink's); 11 chain pump, and bucket elevator.

Several of the above may also be used to lift water, and Nos. 1 and 2 have been described under "Temporary Pumps." As the ram pump is used more often for forcing water to a reservoir than for pumping sewage, it will be described later under "Water-works Pumps."

while the ram or turbine pumps are preferable for high lifts.

HYDRO-PNEUMATIC EJECTOR.—In a flat district, where to obtain self-cleansing velocities in the sewers it would be necessary to raise the sewage at a number of points, or where there are a number of low-lying districts, Shone's hydro-pneumatic system is the most suitable to adopt. It is not economical for lifts of more than 50 ft., and it would be better to divide a high lift into two or more lifts, thus considerably reducing the working costs although increasing the capital cost. It consists of a central air-compressing station, a number at a central station by a vacuum pumping engine through small pipes laid at the uniform depth of 3 ft. The sewage from the house drains flows into a cast-iron syphon box, which is a combined syphon, intercepting and inspection chamber. This box is fixed as near as possible to the house and connected by cast-iron pipes to the sewers. The vacuum is applied at intervals as required, or as experience shows to be desirable. The system is useful in flat districts. The working and maintenance costs are moderate, no manholes, flushing or ventilation are required, there is a saving in excavating and in the cost of pipes, and the sewers do not need to be laid in

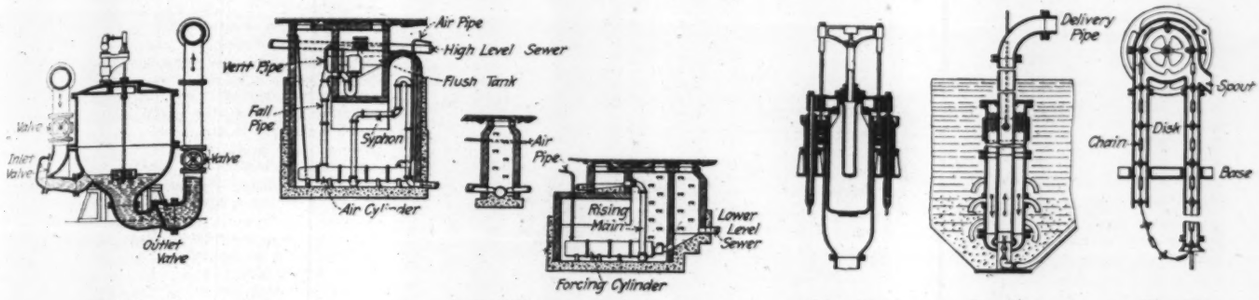


Fig. 11. Fig. 12. Fig. 13. Fig. 14. Fig. 15.

Fig. 11, Shone's ejector; Fig. 12, Adams' auto-ram sewage lift; Fig. 13, Ellington's hydraulic pump; Fig. 14, Caink's air lift; Fig. 15, Chain pump.

FIGS. 11 TO 15. OTHER TYPES OF SEWAGE PUMPS.

CENTRIFUGAL PUMPS.—The centrifugal pump (Fig. 7) consists of a cast-iron casing composed of two chambers, one within the other. The central chamber is connected with the suction pipe and the outer chamber with the delivery pipe. A steel spindle is fitted in the center of the casing, and has fixed to it a wheel or impeller with vanes which are curved backwards from the direction in which the wheel revolves. As the wheel revolves the liquid is drawn up the suction pipe and enters the central chamber from both sides of the wheel. Its vanes give a quick circular motion to the liquid which passes with considerable force into the outer chamber and up the discharge pipe.

This type is one of the most suitable form of pumps for raising a large volume of water or sewage to a moderate height, say, to 20 ft., where the maximum efficiency is about 70%. Recently, however, it has been extensively used for higher lifts for water by placing several pumps on one shaft, making the delivery pipe of one pump the suction pipe of the pump above. High-pressure multiple-chamber pumps will efficiently raise liquid to heights up to 500 ft. The Gwynne-Sargeant pump (Fig. 8) is one of this type and consists of a number of sets of vanes each of which revolves in its own chamber, but which are all fixed on the same shaft. The liquid flows from one chamber to the next, and finally passes out up the delivery pipe. The delivery pressure of the liquid is proportional to the number of chambers used. The centrifugal pump has the following advantages: Simple and strong construction, with no valves to get out of order, and few spare parts required; capital cost, moderate; weight, floor space, and foundations, small; quickly constructed, delivered and erected; flow continuous and operation steady; quickly started; will work horizontally or vertically; can be driven by electric motor, steam, gas or oil engine.

TURBINE PUMPS.—The turbine pump may be used for pumping sewage or water, and can be used for high or low lifts. There are several forms for high and low lifts, the former being made with single and multiple chambers. Fig. 9 shows Mather and Platt's multi-chamber high-lift pump. This consists of three main castings bolted together, the first of which forms the bed-plate, one end cover and the water inlet. The second part is a disk containing the expanding guide passages, which conduct the liquid from the periphery of the first wheel to the center of the second one and then from the periphery of the second wheel to the center of the third wheel and out through the discharge pipe. These passages take a spiral course so that the liquid does not change its direction suddenly. The third casting forms the other end cover and the water outlet. When starting, the pump is filled with water through a funnel and pipe.

This type, like the centrifugal pump, has no air vessels, and no shock due to reciprocating parts. The capital cost is usually higher than the centrifugal pump, but the efficiency is greater. The high speed of the turbine pump is suited for coupling direct to an electric motor; it is compact, and generally the turbine possesses most of the advantages of the centrifugal pump. In the low-lift turbine pump (Fig. 10) the liquid enters at the side of the pump, at and around the axis, and is forced by the impeller through guide passages into the collecting chamber formed in the outer casing of the body. Generally speaking, the centrifugal pump is more suitable for pumping a large volume of water to moderate heights,

of brick, iron or concrete chambers containing the ejectors, and compressed air and rising sewage mains. The sewage gravitates to the ejector (Fig. 11) through an inlet pipe, and rises until it reaches a certain level in the chamber, when it raises a bell float which opens the compressed air valve and closes the sewage inlet valve. The air forces the sewage through the outlet valve into the rising main until the sewage falls to such a level that the cup fixed to the bottom of the spindle is unsupported and drops, pulling down the float and shutting the air valve. The sewage then flows into the ejector again and the process is repeated.

The ejectors are usually placed in duplicate and worked alternately, one filling up while the other discharges, and, if necessary, one can work alone while the other is being inspected or repaired. The efficiency is only from 30 to 40%, owing to the difficulty of keeping joints and valves airtight, friction in the air main, loss of heat and inability to work the air expansively. The size of the air mains must be carefully considered, as the loss of power increases as the size of the main decreases.

This ejector possesses the following advantages: Simple and strong construction; can lift sewage without screening except in small ejectors; working costs moderate; working parts few, and do not easily get out of order; costs of maintenance and depreciation usually small; straight lines, or with even gradients. The disadvantages are that on a large scale the first cost would be considerable; the storage of sewage in the syphon boxes near the houses is objectionable; and the sewage, being separated from surface water, is foul and more difficult to deal with at the sewage works. A separate system of sewers is required to deal with rain water in this and generally in the Shone system.

AUTOMATIC SEWAGE LIFT.—The sewage flowing from the high portions of a district may be utilized by means of Adams' auto-ram Sewage Lift" (Fig. 12) to raise the sewage from the low portion to an intercepting sewer. The high level sewage enters a screening chamber, the clearer liquid passing into an automatic flushing chamber while the solids and a portion of the liquid flow down another sewer. The contents of the flushing chamber discharge into the "air cylinder," drive the air in the cylinder out through an air pipe to a "forcing cylinder" situated on the low level sewer, and forces its contents into a rising main. The liquid in the air cylinder is drawn off by a syphon attached to it and flows away into a sewer leading to the intercepting sewer, and the air cylinder is then ready for the next discharge.

This system has the advantage of being simple in its action and construction; the working costs are nil; no attendants are required beyond an occasional inspec-

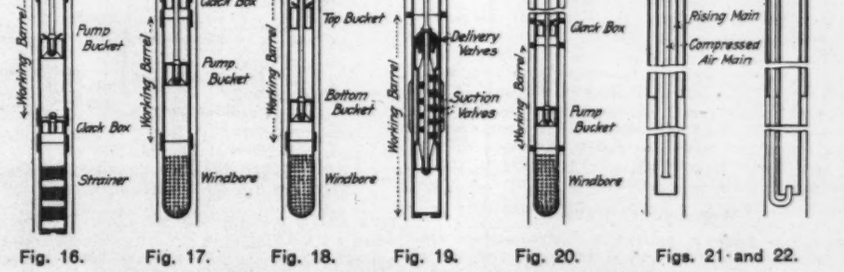


Fig. 16. Fig. 17. Fig. 18. Fig. 19. Fig. 20. Figs. 21 and 22.

Figs. 16 and 17, Bucket pumps; Fig. 18, Concertina pump; Fig. 19, Ashley pump; Fig. 20, Bucket and plunger pump; Figs. 21 and 22, Air lifts.

FIGS. 16 TO 22. DEEP BORE-HOLE PUMPS.

heavier solids precipitated to bottom and forced out of the ejector first; sudden rush of liquid flushes the sewers; will deal with considerable variations in volumes of sewage; enables house drains and sewers to be laid at shallow depths; intercepts the sewage of each district from the main sewer. Its drawbacks are that capital cost usually is high, depending upon the length of air and rising mains, and the working costs may be higher than pumps driven by steam or gas engines.

VACUUM-PUMP SYSTEM.—The Liernur pneumatic system is in use in several towns on the Continent, but only on a small scale at Stanstead in England. The sewage in this system is drawn to a vacuum reservoir tion; capital cost low; is safe; has no working parts to get out of order; costs of maintenance and depreciation are very low, and no offensive gases are liberated.

HYDRAULIC PUMPS.—Where there is hydraulic power or a natural supply of water with a sufficient head available, instead of using compressed air, hydraulic pumps may be used to raise sewage from the low-level sewers into an intercepting sewer. The drainage of Buenos Ayres is carried out on this system. The sewage gravitates into sumps until it almost fills them, when one of the pumps (which are fixed in the sump in duplicate) is started by a float. When the float falls to a certain level, it automatically stops the pump. Should

the liquid rise while the first pump is working, the other pump is started by another float.

Ellington's hydraulic pump (Fig. 13) consists of a hollow plunger working in a pump cylinder. The plunger contains a hydraulic barrel working on a stationary tubular ram which communicates alternately with the pressure water and exhaust by a hydraulically worked slide valve. The pressure water enters this ram, and the hollow plunger descends, displacing the liquid in the cylinder. A ram and barrel under hydraulic pressure on each side of the pump barrel make the upstroke. The exhaust pressure water discharges into the sewage

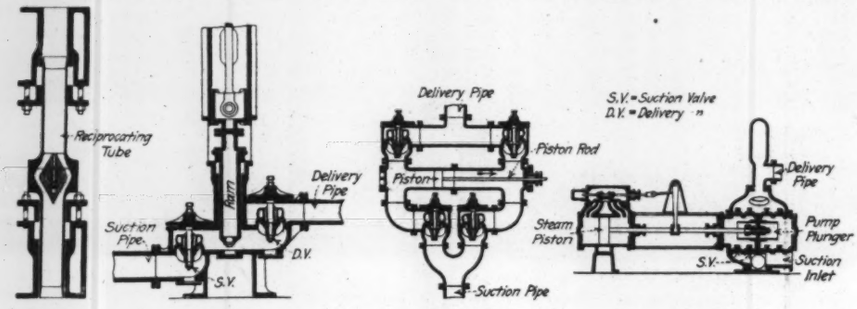


Fig. 23. Fig. 24. Fig. 25. Fig. 26.

Fig 23, Haste pump; Fig. 24, Ram pump; Fig. 25, Double-acting piston pump; Fig. 26, Direct-acting, steam-driven pump.

FIGS. 23 TO 26. OTHER TYPES OF WATER-WORKS PUMPS.

pump cylinder, diluting the sewage and cleaning the barrels.

Provided a natural supply of water is obtainable, this system is economical, the working costs are usually less than Shone's or Liernur's systems, it is compact, the standby losses are nil, there is no risk of explosion, no nuisance from smell, dust, or smoke, and it posseses in addition most of the advantages of Shone's system. The capital cost is rather high.

AIR LIFT.—An air lift apparatus has been invented by Mr. T. Caink, City Engineer of Worcester, England, for raising road detritus and sludge from tanks or wells where there is sufficient depth of liquid to submerge the apparatus. It consists (Fig. 14) of a central vertical discharge pipe with an inlet at the bottom in which is fixed a compressed-air nozzle. The lower portion of this pipe is surrounded with another pipe, in the top of which are a number of small openings to permit the clearer liquid to pass down the annular space and discharge through a number of small branch pipes in the bottom portion of the outer pipe. Compressed air at a pressure depending upon the depth of submergence of its inlet is driven through the nozzle, and the lighter mixture of air and liquid is forced up the delivery pipe by the greater specific gravity of the liquid outside. While the liquid and solid matters are rising up the central pipe the clearer liquid near the surface rushes down the annular space through the branch pipes into the solid matter near the inlet, agitating it, mixing with it and carrying it up the delivery pipe.

This apparatus is working successfully at Wednesbury Sewage Works, and it is claimed for it that no other existing appliance will raise solid matters, *e. g.* road grit, as economically or effectively. The capital, maintenance, and depreciation costs are low.

CHAIN PUMP.—The chain pump (Fig. 15) consists of a series of buckets or disks attached to an endless chain working inside a pipe, and revolving on a shaft at the top. It is sometimes used for raising sludge by hand from sludge wells, but it is not very efficient. It can withstand rough usage, and capital and maintenance costs are low. The bucket elevator or dredger is somewhat similar, but better. It consists of a series of steel buckets fastened to link chains, and is usually driven by belt and spur counter gearing.

Waterworks Pumps.

Permanent pumps at waterworks pumping stations are of two kinds: (1) those raising water from deep wells or boreholes; (2) those lifting water at or near the surface of the ground and forcing it to high-level service reservoirs, or pumping direct to the consumer. The types of pumps usually adopted are as follows: 1, reciprocating pumps, of which there are four types, (a) bucket, (b) bucket and plunger, (c) ram, (d) piston; 2, direct-acting steam-driven pumps; 3, air lift; 4, Humphrey internal combustion pump; 5, centrifugal pump; 6, turbine pump; 7, hydraulic pump; 8, hydraulic ram; 9, syphon. Deep borehole pumps must be of the bucket type, whereas deep well pumps may be of either the bucket or the ram type. The centrifugal, turbine, and hydraulic pumps have been already described under "Sewage Pumps."

RECIPROCATING PUMPS.—The bucket pump (Fig. 16) consists of a gun-metal or brass pump barrel in which a bucket is worked airtight up and down by a pump rod fixed rigidly and connected to the engine or headgear at the surface. At the bottom of the working barrel is a clack box containing a valve opening upwards, and there is another valve in the bucket itself, also opening upwards. A perforated pipe or strainer, termed the "windbore," is fitted to the underside of the clack box. The action is similar to that described in the suction or lift pump. This pump allows the water to flow straight throughout its course, so that excessive friction is avoided and the air is not so liable to accumulate at any place. In Fig. 17 the clack box is fixed above the bucket.

Another form of bucket pump frequently used is the double-bucket or concertina pump (Fig 18). This consists of two buckets, each being connected to the engine by a separate rod. The upper bucket is fitted with a hollow rod, while the lower bucket has a rod which passes through the upper bucket and rod. The buckets work in opposite directions, one ascending while the other is descending. As the upper bucket ascends, it forces water up the rising main, and at the same time the lower bucket descends, forcing water through its valve into the increasing space between the buckets. On the return stroke a charge of water is forced through the upper bucket valve into the rising main by the ascending lower bucket. It is double acting and perfectly balanced, occupies less space and its capacity is greater than the single-acting bucket, but it costs more for repairs and is not so durable.

The bucket pumps described above have two serious disadvantages, viz., the difficulty of access to the working parts for inspection and repairs and the slow speed at which the pumps have to run, the piston speed of the pump being only from 80 to 120 ft. per min.

These disadvantages have been overcome in the Ashley patent pump (Fig. 19). This consists of a single working part, the bucket, which is a long tube with piston-like ends, open at the bottom with delivery valves fixed at the top. The ends are connected by an octagonal or hexagonal waist fitted with a number of suction valves. The working barrel is the bottom of the rising main and is provided with a number of water inlets which are arranged so as to be always uncovered by the piston ends. On the upstroke, water passes through the suction valves into the bucket, and on the downstroke the suction valves close and water passes through the delivery valves into the upper part of the barrel and in the next stroke into the rising main. This pump is durable, simple, and quiet in its action, its working parts are easily accessible and it can be run at a much higher speed than the ordinary bucket pump.

The bucket pump is sometimes combined with a plunger (Fig. 20). The plunger is only about half the area of the barrel, and is fixed to the pump rod above the bucket and near to the surface level. It is double acting, half the water being lifted to the delivery pipe on the upstroke, and half being forced up the delivery pipe by the plunger on the downstroke.

When the lift is high it is usually divided into two lifts at the surface level, the lower portion being raised by bucket pumps into a surface tank, from which it is forced up to the reservoir by ram pumps.

The Haste patent pump (Fig. 23) is [illegible] of reciprocating pump, and comprises [illegible] expanded at the center and reciprocating glands fitted at the ends of the suction pipes. In this expansion tube is [illegible] guided on a spindle. The pump is so [illegible] liquid flows between two guiding surfaces [illegible] panded tube and the conical valve [illegible] stop. The tube is worked at a high [illegible] suction stroke the valve closes forming [illegible] which rushes liquid at a high velocity, [illegible] before the end of the suction stroke, [illegible] the delivery pipe. A continuous flow [illegible] maintained by its inertia through the [illegible] ing which the pointed valve moves [illegible] with a small amount of resistance. [illegible] the makers that this pump has the [illegible] trifugal pump with the power and efficiency [illegible] pump. It works efficiently, as all the [illegible] the flowing liquid does useful work, [illegible] sudden changes in the direction or area [illegible] compact, the capital cost is moderate, and [illegible] efficiently at high or low speeds.

The ram pump (Fig. 24) consists of [illegible] in which works a ram or solid plunger [illegible] valves. There are suction valves and [illegible] on the suction and delivery pipes. The action is similar to that in the bucket pump. This pump is more suitable for pumping gritty water or for high lifts than the bucket or piston pumps, as there is less friction due to the smaller wearing surface and it can be run at a higher speed. It is made with single, double or treble rams.

The piston pump, which has been previously described, is also made double acting, *i. e.*, the water is forced up the delivery pipe both on the forward and backward strokes (Fig. 25). In this pump the piston has no valve, and reciprocates in a barrel which is connected to the suction and delivery pipes by four valves, two to each pipe. When the piston moves to the left, the water in front of the piston is forced through the delivery valve A, and water enters behind the piston through the suction valve C. On the return stroke, the water is forced through the other delivery valve B, and flows behind the piston through the other suction valve D.

STEAM PUMPS.—The direct-acting steam-driven pump (Fig. 26) may be single or double acting. In both types there is a steam piston working in a cylinder and connected by a rod to a pump piston or plunger working in a pump barrel at the other end. They are frequently arranged in pairs, when they are known as duplex pumps. This type is durable, the capital and maintenance costs low, occupies small space and can be quickly erected, but it is uneconomical in steam consumption and cannot be worked expansively.

AIR LIFT.—The air lift may sometimes be suitable for raising water from boreholes, for example: (1) Where the borehole is in an isolated or inaccessible position and the cost of erecting a new pumping station over it would be excessive; (2) where there is an existing pumping station in which air compressing plant could be cheaply installed and compressed air delivered in an air pipe to the borehole; (3) where a larger volume of water than can be obtained in the ordinary way is necessary. It consists of two pipes, the larger one being the rising main, and the smaller one an air pipe which may be either inside, as in Fig. 21, or outside and turned up inside at the bottom of the rising main (Fig 22). Compressed air is driven down the air pipe, presses on the water and forces it up the delivery pipe. This system has the following advantages: No machinery in the borehole to get out of order; a number of boreholes or wells can be worked from one compressing station; no attendants required except at the station; it raises more water in a given time than any other system; it can be quickly fixed; it is not affected by frost; it aërates the water.

The fuel consumption is high, and to obtain the requisite amount of immersion the borehole may have to be extended to a greater depth than would be necessary with bucket pumps driven by gas or steam engines. It is economical to work the air compressors in two-stage machines with inter-coolers, and the air should be as cool as possible.

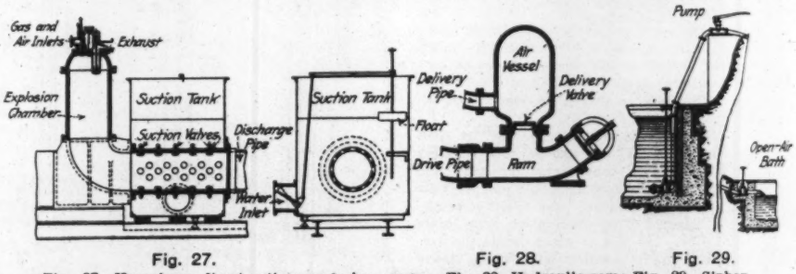


Fig. 27. Fig. 28. Fig. 29.

Fig. 27, Humphrey direct-acting explosion pump; Fig. 28, Hydraulic ram; Fig. 29, Siphon.

FIGS. 27 TO 29. SPECIAL TYPES OF PUMPS SOMETIMES USED IN WATER-WORKS.

HUMPHREY DIRECT-ACTING EXPLOSION PUMP.—A new type of pump, fully described by the inventor, Mr. H. A. Humphrey, at a meeting of the Institution of Mechanical Engineers in November, 1909, is the Humphrey internal combustion pump.* This pump (Fig. 27) consists of an explosion or combustion chamber fitted with a gas and air inlet valve, and an exhaust valve for the burnt gases, which mutually control each other. Between the combustion chamber and the discharge pipe is fixed a cylindrical valve box which contains a number of holes each fitted with a gunmetal valve held on its seat by a light spring. This valve box is surrounded by a suction tank connected to the suction inlet pipe. A float controls the inlet to the suction tank, and this in turn regulates the volume of gas and air admitted to the combustion chamber. The gas and air are ignited by a spark-plug, explode and drive the liquid up the delivery pipe, giving it a store of kinetic energy which maintains the flow of liquid towards the high level tank, until the pressure on the underside of the water valves is less than that above and the difference of pressure causes these valves to open. Liquid flows through the valves into the valve box, part following the column of water still moving to the high-level tank, and part to the combustion chamber expelling the exhaust gases. When the liquid reaches the exhaust valve it closes both the exhaust and water inlet valves. The small volume of burnt gases remaining in the combustion chamber acts as a cushion, brings the column of liquid to rest again, expands and forces the liquid down, and creates a vacuum. The gas inlet valve is only held by a light spring and opens, admitting a fresh supply of gas and air. The head of liquid in the delivery pipe forces the liquid back, compressing the gas and air and closing the inlet valve. The charge is ignited, and this cycle goes on as before.

This pump may be used for pumping screened sewage by making the water inlet valves slightly larger. It is durable, simple, and certain in its action, and when once started will work efficiently under considerably varying conditions. Capital, maintenance and depreciation costs are low. It is economical in gas consumption, can start immediately, requires little lubrication or attention, and there is no danger of gas contaminating the water. The drawback is that it is bulky, but as it chiefly consists of pipe-work a large portion of it may be fixed outside the engine-house. Where used for high lifts a small air vessel is fixed at the end of the discharge pipe close to a large air vessel into which the pressure water flows. An installation of five pumps, capable of raising 180,000,000 gals. of water per day, is to be erected for the Metropolitan Water Board at Chingford, England.

*Described in Eng. News, Dec. 2, 1909, p. 603.

HYDRAULIC RAM.—The hydraulic ram (Fig. 28) is useful where there is a sufficient volume of water, having a head of from 18 ins. to 10 ft., to raise a moderate volume of water to some high isolated portion of a district. The water working the ram flows through a drive pipe into a vessel, and escapes through a valve into a suitable tail race until it attains a sufficient velocity to close the valve. This creates considerable pressure in the ram and opens a delivery valve, through which the water rises into the air chamber and up the delivery pipe. When the flow of water which closed the escape valve ceases, the valve reopens, and so on. It is sometimes made double acting, being capable of using dirty water to raise clean water. It is simply and strongly made, its efficiency is about 50%, capital cost low, cost of maintenance almost nil. It requires little attention and no lubrication, will work when flooded, and is unaffected by the tail water.

SIPHON.—The siphon (Fig. 29) is a hydraulic machine sometimes used to draw off water from a higher to a lower level in tanks, reservoirs or wells, although a high obstacle, in practice not exceeding 25 ft., intervenes. It consists of a bent tube or pipe, forming two legs of unequal lengths. Both pipes are fitted at the ends with retaining valves, and filled with water, generally by a small pump. When the valves are opened, the greater head of water in the outer or longer leg causes it to rush out by gravity, creating a vacuum in the pipe and starting the siphonic action. The siphonic action continues until the water reaches the level of the inlet to the short leg, or the height of the water into which the outer leg discharges reaches the same height as the tank which is to be emptied. Provision must generally be made for allowing the air to escape at the top of the tube, or to exhaust it, if the siphon is used intermittently. In practice it has only a limited use for water supplies; but it has been largely used, especially in its annular form, for sewerage and sewage disposal works.

Space does not permit of saying anything on the design of pumps beyond that a good pump should be durable, simple, certain in its action and economical in power. The working parts should be such that they can be easily inspected, repaired or replaced. The waterway should be as large as possible and the pump should be capable of working efficiently under varying speeds and of delivering a constant and sufficient flow of liquid.

Paving and Care of Streets by Street Railway Companies.

The requirements of municipalities in regard to the paving, repair and cleaning of streets by street railway companies having tracks upon these streets are of a very diverse character. The accompanying table gives particulars as to the requirements imposed in several large cities, and gives also some particulars as to the track construction and paving material in each case.

The groove or flangeway for the car wheels may be formed in various ways. With grooved rail, it is in the rail and quite independent of the paving; thus the paving can be laid level with the rail head, leaving the street surface broken only by the comparatively narrow grooves. With T and T-girder rails, a similar effect may be obtained by the use of nose blocks or nose bricks laid inside each rail. With these two forms of rails, however, and also with step-head rails, a depression of the paving is used sometimes instead of a sharply defined groove. Thus between T rails the pavement may be crowned so that at each side it is level with the bottom of the rail head while at the middle it is level with (or slightly below) the top of the rail head. This arrangement is less satisfactory than the others,

PAVING AND CARE OF STREETS BY ELECTRIC STREET RAILWAY COMPANIES.

RAILWAY.	PAVING MATERIAL		FLANGEWAYS.		RAILWAY CO.'S STREET WORK.				CONCRETE BASE.					Sub-grade Rolled	Trouble With Dirt or Wheel Flanges on Groov'd Rl.
	Between Rails and Tracks.	Remainder of Street.	In Paved Street.	In Macadam.	Pave.	Sweep.	Sprinkle.	Clear Snow.	Under Paving.	Under Width of Track.	Stringer Under Rail.	Thickness of Base or Stg. Piece, ins.	Ties Embedded in Concrete		
1 Albany	Asph., brk., etc.	gran. blk.,	Groov. rail	Groov. rail	Yes	No	Yes	Yes	Yes	No	No	.....	No	Yes	No
2 Atlanta	Asph., brk., bitulith.	gran. blk.,	Groov. gir. rail.	Groov. gir. rail.	Yes	No	No	No	Yes	Only with rail in	9-in. Trilby asphalt.	Under rail 10 under tie 4	Only with 9 in. Trilby rail & asp.	Yes	No
3 Baltimore	Belg. blk., cobble,	slag. blk., vit. brk.	Tram-head rails.	& gro. gir.	Repairs only	No	Yes	Yes	Recently	No	No	.....	Rarely	.....	Some
4 Chattanooga	Brk., Belg. blk., chert. (No asph.)	Asph., brk., Belg. blk. chert.	Stretcher brick	Stretcher brick	Between & 1 ft. outside rail.	No	No	No	Yes	No	Yes	.....	No	No	T-girder
5 Cincinnati	Asph., brk., tarvia, bitulith.	wd., gran., macadam,	Groov. rail	Groov. rail	Only if Co. disturbs it.	No	Yes	Yes	6 in. con.	Yes	Yes	5 to 8 under ties	.....	Yes	Dirt collects
6 Cleveland	Medina stone, brk., (No asph.)	As., Medina sd. stone, brick.	Groov. rail	Groov. rail	Yes	Yes	Yes	Yes	Usually	Yes	Yes	10	Yes	No	No
7 Columbus	Brk., asph.,	stone blk.	Specl. blk. with T-rail	.....	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Stringer 18 ins., base 12 to 14 ins. high	Largely	Only soft ground	Yes
8 Denver	Basalt concrete with bas. block toothing.	Asphalt or sandstone brick.	Beveled ba & T-rail.	salt block	Between & 1 ft. outside rail.	No	No	Only to facilitate operation.	Yes	Yes	No	6 bet. ties	Yes	No	No gir. rails
9 Detroit	Same as remainder.	Various	Gran. nose blk.	Gr. nose blk.	Yes	No	Yes	Yes	Yes	Yes	No	8 under ties	Yes	When possible	Yes
10 Houston	Mostly brick	Mostly brick	Spec. brk.	.....	Yes	Yes	Yes	No snow	Yes	Yes	No	14 (6 under, 2 over ties	Yes in pavt.	No	Yes
11 Milwaukee	Gran. blk., asphalt, brick.	Asph., brk., Kettle Riv. sandstone.	Block set under T-rail head.	Mac. under T-rail head.	No	No	No	Yes	Yes	Yes	No	6 under ties	Yes	No	No gir. rails
12 Minneapolis	Gran. blk.	As., gran., creos. blk.	Nose block	Stone kept away from rail.	Yes,	(all); Co.	pays the	city.	Yes	No	Ties on bal. last; conc. bet. ties.	.....	Conct. between	When soft	T-girder
13 Mobile	Asph., brk. block.	and wood	Nose brick	& gr. rail.	City paves Co. pays	No	No	No snow	Yes	No	String. 20 wide, 44 long; ties 48 apart	Str., 8	No	Tamped	No
14 Philadelphia	Gran. blk., mainly.	Asph., brk., macadam, gran. blk.	Groov. rail	.....	Pays city lump sum yearly.	No	No	No	In bus. section.	Not with ties	Yes	.....	No	When soft	No
15 Pittsburgh	Stone blk.,	brk., asph.	Groov. gir. rail.	.....	Yes	No	Partly	Yes	If req. by city.	Not under track	No	.....	Only when con. base under pav.	Yes	No
16 Seattle	Asph., brk., blk., gran.	sandstone blk.	Nose brick	.....	All but laying asph.	Some	Some	Some	Yes	Yes	Yes in string. const.	Base, 5 ins. strg., 12 deep 16 wide	In paving	When possible	Yes
17 Washington	Asph., with scoria blk. stretcher; Hassam stone;* creos. wd; macadam.	Asph. with scoria blk. or Hassam stone str cher blk.	Groov. rail	Stone graded to bottom of rail head.	Yes (See note)	No	No	From track	Yes, except macadam.	Only with conduit c. i. yoke s		const. with	No	For surface track	(See Note)

NOTE.—Washington, D. C.: The company is required to pay for all paving in and between the tracks and for 2 ft. adjacent thereto in all streets. It is not required to sweep, sprinkle or remove snow, but does remove snow from its own tracks. There is no trouble with dirt in the groove of the "Trilby" rail with flaring groove. The old style full-grooved rail is troublesome in snow.

*Hassam stone preferred.

especially from the municipal point of view, as it gives an irregular form to the surface of the pavement and the rails offer a greater obstruction to the wheels of vehicles crossing the street or turning out of the track.

Where grooved rails are used there appears to be comparatively little trouble from dirt and snow packing in the groove; this is due largely, no doubt, to the general use of rails in which the groove is flaring on the guard side and has the guard slightly lower than the rail head, so that the wheel flanges may force the dirt out at the side of the groove. With narrow grooves the trouble is likely to be accentuated.

The Construction of a Paris Subway Over Old Gypsum Quarries.

Line No. 7 of the Metropolitain subway in Paris, France, has its terminus near the Buttes-Chaumont Park in a district which is underlain with a succession of old gypsum quarries which were worked from medieval times up to the middle of the 19th century. The quarries comprise a great number of open galleries, some

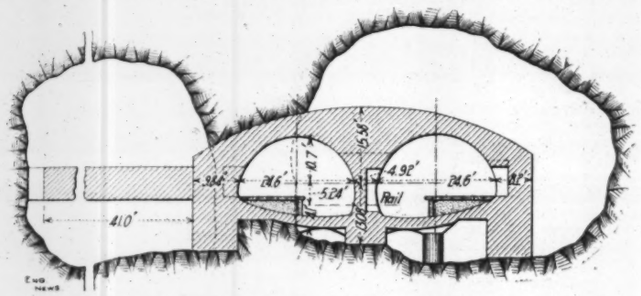


FIG. 1. TRANSVERSE SECTION THROUGH BUTTES-CHAUMONT STATION, PARIS METROPOLITAIN SUBWAY.

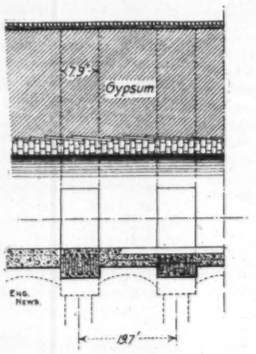
30 or 40 ft. in either direction, and of about the same height, separated by supporting pillars, 20 to 30 ft. in diameter. These galleries are, as a rule, all on one level, about 40 ft. below the surface of the ground, but in some places the workings are at as many as three levels, extending down to a depth of 130 ft., with intervening roofs 20 to 30 ft. in thickness. The rail elevation of the subway through most of this district is about 10 ft. above the roof of the highest quarries, though in some places this elevation drops or the gallery rises so that the tube passes through one of the old quarry openings. These galleries have been filled in times past with a mixed fill of sand and clay, which, of course, does not completely reach to the roof and which is very loosely placed. It is obvious that this peculiar condition required some special design for a permanent solid footing for the subway. The solution which has been successfully applied is fully described in a recent issue of "Le Genie Civil" by M. Suquet, one of the engineers on the work. From that article we have prepared the following short abstract:

The general type of section for this portion of the subway is an arched opening, divided into two parts at the stations by an interior wall but narrowed sufficiently between stations to accommodate the two tracks in one clear opening. The entire length through the quarry district is about one mile and in this distance there are several special types of section, but, as a rule, the general section—arch, floor and walls—is built of concrete masonry, reinforced so as to tie together in a unit to resist the heavy stresses due to the loose loading above and the peculiar foundations below. In some portions a rubble masonry arch rib was used throughout. The subway is so low as to require it to be dug in tunnel.

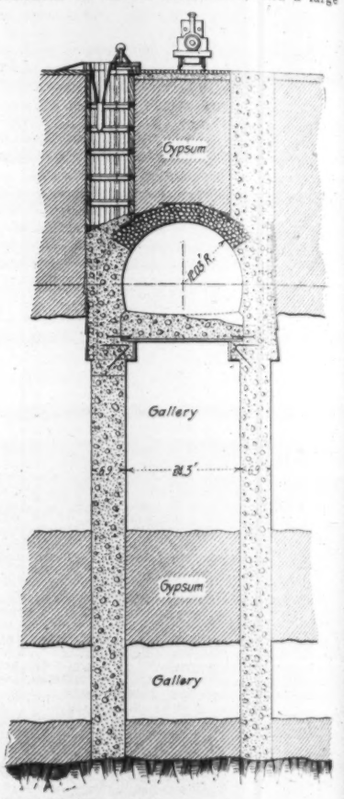
Two general types of construction were employed to give stability to the footings through the galleried district; (1) where the subway itself passed through some of the high-level galleries; (2) where the presence of two or three superposed galleries made it imperative to carry the footings of the tunnel down below the lowest gallery.

Fig. 1 represents a typical section built where the subway passes through a gallery. This is entirely of concrete reinforced only along the bottom and on the floor, as shown. It will be noted that where possible the structure rests directly on the solid floor of the quarry, but where that is too low, the floor is supported by intermediate concrete pillars. In all cases, this requires the reinforcement of the floor as a beam. Furthermore, in order to take care of the side thrust coming down the arches to the sidewall, it was necessary in many places where the old gallery was very wide to interpose a horizontal beam, as shown in Fig. 1, extending from the sidewall of the subway through the old fill to the sidewall of the quarry. Fig. 1 is a section through a station, so that tubes are shown in the regular section. The regular opening is made of a single archway.

In the vicinity of the Place de Danube the presence of three superposed galleries required the second type of construction, which is shown in Fig. 2. This was built for a distance of 1,300 ft., 250 of which were in a double-tubed station. The solid bottom of the longest quarry was as deep as 120 ft., and it was thought necessary to carry the footing to this bottom. This was done by supporting the thoroughly tied together subway section on concrete pillars, 7 ft. in diameter, extending to the bottom, thus forming a sort of viaduct within the earth. Inasmuch as it was thought dangerous to attempt to hold the tunnel roof while such pillars were being sunk from the tunnel bottom, it was decided to sink the shafts in which the pillars were afterwards to be placed from the surface of the ground, some 30 ft. above the roof of the tunnel. In all, 220 of these shafts were sunk, 200 of which were dug from the ground surface.



Longitudinal Section.



Cross Section.

FIG. 2. DETAILS OF PARIS METROPOLITAIN SUBWAY IN SECTION THROUGH THE OLD GYPSUM QUARRIES.

Each shaft was in two distinct parts. The upper section extending to the bottom of the tunnel was square, 8 × 9½ ft. in plan, and was dug in open air between timber framing. The lower part was circular, 7 ft. in diameter, and was sunk from the bottom of the first section, still in open air, inside steel tubing. The ground was sufficiently dry so that compressed air was not required, but the ventilation was carried on through pipes which led down from the surface.

Fig. 2 shows the nature of the construction. Briefly, it consists of a rubble masonry archway supported on solid concrete sidewalls, which were in turn supported on small longitudinal arches sprung between the adjacent pillars. The floor is of solid concrete, supported on transverse reinforced-concrete beams, spanning between corbels which are built out from the pillars.

In the construction, the shafts were first sunk and filled with concrete up to the base of the arch roof. The tunneling was then carried on through a center cut and extended gradually to the sides where the rubble arch was footed against the concrete of the pillars. Excavation was then continued lower to the level of the cross-beams, which were then placed and finally the longitudinal supporting arches and the remainder of the sidewall was completed. The upper parts of the shafts were filled with concrete in most places to within 5 or 6 ft. of the ground surface. This was done in order to provide a sort of retaining wall against any further slides of the loose ground on top of the tunnel.

This section of the subway is now in operation, and no appreciable deflection or movement has been noted in it.

Construction Work on the Key West Extension of the Florida East Coast Railway.*

By L. M. THATCHER.†

When the extension of the Florida East Coast Ry. from Miami to Key West was started, the work was so novel that no contractor would make a bid, so the entire work of construction was organized under the direction of Mr. J. C. Meredith, with the title of Constructing Engineer, with headquarters at Miami, Fla. At headquarters were located the office engineer, bridge engineer, a corps of designers and draftsman, the storekeeper, the head steward, the paymaster, superintendent of docks and boats, and a large force of bookkeepers and clerks. In the field the principal assistant engineer directed the work, using a launch on which he lived, except when at headquarters. The general foreman took the place ordinarily filled by the contractor, and all head foremen, captains of dredges, excavators, pile drivers, etc., were directed by him.

One division engineer handled from three to six residencies, and was allowed a launch to cover the work and get from Key to Key. The resident engineers had charge of from five to ten miles of work, usually on one Key, though sometimes two, or a stretch of water work between. His force consisted of an assistant resident, who acted as transitman, a levelman, two rodmen, head timekeeper with an assistant, and a steward, who looked after all subsistence. Each residency or camp had also a head foreman and as many gang foremen as necessary. The head foreman had direction of the gang foremen and laborers, much as a contractor or his superin-

*Abstract of a paper presented before the Engineering Association of the South on April 12, 1911. Other articles on the Florida East Coast Ry. will be found in Eng. News., Oct. 19, 1905, p. 407, May 9, 1907, p. 504.

†Atlanta, Ga.

tendent would, though he was under the direction of the resident engineer.

LABOR.—As many camps as possible were opened with negro labor; but the supply was short, and recourse was had to white labor from the North, and obtained mostly at New York and Philadelphia. Some 10,000 men were obtained in this way, though not more than 5,000 or 6,000 were at work at any one time. A great deal of care was taken in the selection of these men by the agents, but in spite of this a great many poor and worthless hands were obtained. Transportation was furnished each man, which was charged against him, and he was allowed to pay it back in small installments at his convenience.

This labor was made up of all classes, from the clerk out of work to the worthless bum who did not intend to work, and even criminals. The men had tents furnished them, and good, substantial food at a nominal cost, or they could board themselves from the commissary, as they chose. For any who really desired to make money and save it, the situation was admirable, as there was absolutely no way to spend it, except by going to Miami or Key West.

METHOD OF HANDLING THE WORK.—In order to appreciate the extreme difficulty encountered in handling the work of construction, it is only necessary to know that every man, tool, machine, materials, provisions, and even water for cooking and drinking, had to be transported from Miami by boat. All of this traffic was handled by a fleet of Mississippi River steamboats, constructed to run in very shallow water, for the route used was on the inside of the Keys.

The camps were selected in the most suitable places on the various Keys as regards boat landings and convenience for the work. Clearings were first made of the camp site and a rough dock or landing place constructed, at which the steamers could tie up and unload.

Some 15 camps were in operation at one time, each a unit by itself, and handling from 250 to 500 men each, so that the work was progressing on half the Keys at once. As fast as a camp completed its work at one Key it was moved to another.

At first houseboats were used to house and feed the engineers and foremen. Later portable buildings were used for the purpose. As previously noted, tents were erected for the housing of the men, for cooking and serving food, etc. The commissary privileges were let to Miami parties, and each camp provided with a commissary building or tent and a commissary clerk. The engineers' and foremen's salaries included subsistence.

At first the clearing and grading was done entirely by gangs at day wages. Later a part of this work was let by the station to some of the more enterprising of the men, and nearly all of them made several times as much as they would at day wages. The right of way was in most instances 100 ft. wide, and the clearing was classified as follows: Extra heavy hammock, hammock, second-growth hammock, scrub, old field, black mangrove, red mangrove.

The grading on the land portion was largely in fill made from borrow pits on the right of way, though in a few places cuts were made. Nearly all of the Keys, however, lie below the established grade line. The larger portion of the borrow was in coral rock, though occasionally sand composed of disintegrated coral rock or shell was found. A peculiarity of this coral rock is that, though soft when first put in embankment, after a time it hardened and afforded an excellent protection against wash. At one or two camps teams were used, but most of the material was handled with wheelbarrows.

Excavation was classified as follows:

	Depth, ft.
First class	0 to 0.8
Second class	0.8 to 2.0
Third class	2.0 and over
Embankments:	
First class	0 to 0.8
Second class	0.8 to 2.0
Third class	2.0 to 4.0
Fourth class	4.0 and over

At Camp No. 5, on Lower Matecombe Key, the average costs per cubic yard of embankment were as follows:

Grubbing, $2.94 per station	$0.01
Drilling, $0.068 per ft.	0.23
Blasting—	
Labor	0.030
Labor and materials	0.236
Dynamite, lbs.	1.16
Grading	0.45
Total cost rock	0.936
Total cost sand	0.379

The above figures show average costs. The costs were reduced slightly more than 50% as the work progressed and became more systematized.

In addition to embankments put up by hand on the land work, some were made in sand, by orange-peel excavators operated by gasoline engines, the whole outfit being moved on a temporary track on the fill which the excavator had made. With care these embankments made by excavator were kept to within a few inches of grade, so that very little dressing was required. Work was put up in this manner for from 6 to 8 cts. per cu. yd.

The embankments through low and swampy lands were made by clam or orange-peel dredges mounted on lighters, which floated in water in trenches they had dug. The lighter was hauled ahead and made fast with lines from the shore.

Between the Keys the water fills were made by suction dredges. Overlying the coral rock at the bottom or under the water is a layer of muck, marl, or shells from 1 to 10 ft. in depth, except at the channels, where there was no such accumulation. This material was pumped by the dredges and conducted by pipes to the desired location. No unusual difficulty was experienced in making these fills, apart from the channel portions, or until the fill approached the surface of the water, when a single storm would wash away the work of weeks and perhaps months.

An engineer with a rodman or two was assigned to each dredge, whose duty it was to look after grade, line and reports. All dredge work was under the direction of a superintendent of dredges, and this part of the work was separate and distinct from the land work.

Great difficulty was encountered at the channels or wherever the current was rapid. It is surprising what a swift movement of the water is created where the rise and fall of the tide is seldom over 2 ft. and usually not exceeding 1¼ ft. The difficulty encountered in the wash was finally overcome by the use of sheet piling or similar devices. The slope of these embankments was 2 to 1, riprapped to a depth of 36 ins. on the seaward side and 12 ins. on the bay side. Some of the stone for riprapping was moved to its place on lighters or barges, and some on a temporary track laid after the embankment was above water.

On the grading work some eight steamers composed the fleet, besides any number of launches, small boats, lighters and barges. The steamers were kept busy moving men and transporting supplies for the commissaries. To keep 5,000 or 6,000 men moving and well provisioned was in itself no small job, and the fleet was about the most important part of the work,—at least we thought so who were isolated on the Keys—and the arrival of a boat with supplies and mail once or twice a week was an event greater by far than train time in a country village.

Speaking generally, this was the order of construction: Grading land work, grading water work, abutment and bridge work, docks, and, finally, concrete arch work.

REPORTS.—The system of reports was most complete, and occupied a large part of the engineers' time. On the land work they were as follows:

(1) Labor report, showing for each day of the week the total number of laborers in camp; days shown for day gang in weekly distribution; number of contractors and contractors' helpers; number of sick in camp; hours of rain; number of engineers, including instrument and rodmen; number of foremen; number on camp subsistence; and all salaried employees.

(2) Weekly cost report, showing the number of the report, the date, section, and camp; location of work by station; acres of clearing completed during week; class and cost; foremen or contractor; grubbing, cost; drilling, number of holes, total depth, and cost; blasting, pounds of dynamite, number of exploders, number of caps, feet of fuse and costs, grading, cubic yards of excavation, cubic yards of embankment, cost, foremen, and class.

(3) Monthly cost report. This was a summary of the weekly reports under the same headings.

(4) Cost of finished-work reports, showing number of report, date, section, and camp; station, clearing, acres in completed station, foreman or contractor; grubbing, cost per station; drilling, number of holes, total depth, and cost per lineal foot; blasting, pounds of dynamite, number of exploders, number of caps, feet of fuse, cost of labor, and cost per cubic yard of blasted material; grading, cubic yards of excavation, cubic yards of embankment, cost per cubic yard, foreman and class.

These reports were called for by the principal assistant engineer, who made the trip over the line from Miami to Key West each week.

MEDICAL ATTENTION—HEALTH.—Each camp, dredge or houseboat, as the case might be, was provided with a very complete supply of medicines, bandages, etc., to be used as a sort of first aid. The one or two men found most capable for the work did the doctoring for the camp. The company physician made the rounds of the camps once a month, or oftener if necessary. Any patients who could not be properly treated in camp were sent to the well-provided company hospital in Miami and cared for without charge. As a whole, there was very little sickness, and the health of all the men on the Keys was remarkable in that almost tropical climate. Bathing in the salt water could be indulged in every day of the year, so that there was no excuse for uncleanliness. No fresh water was allowed for bathing purposes, and a good fresh-water bath on reaching civilization was a luxury indeed.

GENERAL REMARKS.—The day in camp was begun with rising at 5 a. m.; breakfast, 5.30 a. m.; work, 6 to 11 a. m.; noon hour, 11 a. m. to 12 m.; work, 12 m. to 5 p. m. The food provided was at all times good and substantial, with turkey dinners on holidays for the engineers' mess.

One of the greatest treats on the Keys was the supply of fresh fish, which greatly helped out the larder. These were bought in lots of from 300 to 500 lbs. at 3 cts. per lb. live, and kept in crates submerged in the water.

The temperature on the Keys is not so oppressive as one would expect, and there is a breeze most of the time, which helps out wonderfully. During the year the temperature rarely goes below 60° F. in the winter or above 95° F. in the summer in the shade. The writer found it very comfortable the year round. None of us were, however, burdened with any superfluous clothing, pajamas being a favorite costume for night and day.

Mosquitoes and "booze" boats were the greatest pests—the former night and morning, and the latter all the time. It was absolutely necessary to keep all liquor out of the camps, and, on the whole, we succeeded very well. Now and then some would be smuggled in, and the writer had several personal experiences in quieting disturbances arising from too much Cuban "arguident."

The total estimated cost of the extension is $12,000,000, or, in round numbers, $95,000 per mile. Construction began in the fall of 1905, and it was expected that three years would complete the work. Many difficulties have been encountered, however; and it is now nearly twice that time, and the work is not fully completed, though trains have been operating for some time to Knights Key (25 miles from Key West), at which point a large dock has been constructed, from which steamers operate regularly to Havana.

Extensive docks and terminals are planned for Key West. This includes one large dry dock and ten wharves, each 800 ft. long and 100 ft. wide, with basins 200 ft. wide between. The depth of water will be from 20 to 40 ft. With these harbor facilities, Key West will rank with New Orleans, Mobile, and Galveston as a commercial port.

The Reasonableness of Rates of the Consolidated Gas Co. of Long Branch, N. J., has been investigated by the New Jersey Public Utilities Commission. The Commission based its studies on the value of the property as shown by an appraisal, without allowances for intangible values, good will, early deficits, etc., but with an allowance of 12% for engineering, superintendence and development expenses. The Commission recognized that the actual cost of the plant was some 20% above the valuation, on account of piecemeal construction and the introduction of new apparatus from time to time. The actual evaluation was $1,649,260, but the Commission concluded that about $2,000,000 had been legitimately expended. It was found that not enough depreciation had been written off so that the book value of the property was considerably in excess of the actual. The company was found to be operating at a disadvantage, having an abnormal peak load and a large portion of the plant in use only a short time in the summer. The old rates were 20 cts. for the first 50-KW.-hrs.; 16 cts. for the next 50-KW.-hrs., and 12 cts. in excess of 100-KW.-hrs., with a motor-supply rate of 10 cts. per KW.-hr. for 24-hour service. New rates have been fixed at 15 cts. for the first 200 KW.-hrs.; 12 cts. for the next 200 KW.-hrs., and 10 cts. for all over 400 KW.-hrs., the motor rate remaining 10 cts. per KW.-hr.

This Commission has held also that it has jurisdiction over municipal utilities only so far as to require the use of uniform accounts prescribed for similar private concerns.

FIELD AND OFFICE

Introductory Note.

Under the heading "Field and Office" we desire to collect such news, information and discussions as concern the routine work of the engineer in the designing or drafting office or in the field. Special methods or devices, tools, problems, questions, difficulties of various kinds, occur in great number in the daily work of the engineer; readers are invited to contribute to this department, so that their recorded experiences may be of service to others.

A fuller statement of the purpose and scope of the plan to set apart several pages in one issue each month of Engineering News for Field and Office matters is printed on the editorial pages of this issue.

The most important thing to the working engineer is correctness and precision. Computations are the most obvious case, and in one sense the most vital, because the same spirit and training that produces reliable computation results will also produce reliable work on drawings, in surveys, or in contract handling. We take the liberty of starting out the present pages with the suggestion to every engineer, but particularly to the beginner—who is more liable to "wildness" than the seasoned worker—that he give special attention to accuracy and correctness in his mechanical work. Below there appear various solutions of a rather intricate problem in triangles, which were worked out and submitted voluntarily by computers located as far away as the Philippines. The results reported by the several computers do not agree so well as one might expect from thoroughly careful work. The reasons why these discrepancies may occur merit the reader's consideration. Should they occur? When the ordinary tables are used, much interpolation is required; considering also that at certain points in the solution the difference of two computed quantities is used, it is evident that six significant figures in the result are hardly justified.

The "Roller Case" Pile-Driver Used in the Construction of Permanent Trestle Extension on the Ogden-Lucin Cut-Off.

By C. M. KURTZ.*

The original plans of the portion of the Ogden-Lucin Cut-off that crosses the western arm of the Great Salt Lake called for 11 miles of permanent ballasted-deck trestle with 5.8 and 2.4-mile solid embankment approaches from the east and west shores respectively. These approaches were to be made by gravel trains dumping from a temporary trestle (4-pile bents) which was constructed at the same time as the permanent trestle (5-pile bents).

The last pile in the permanent trestle as originally planned was driven Oct. 26, 1903, and tracklaying was rushed across the trestle as fast as the decking was placed, so that by the middle of the following month steel had been laid on the cut-off without any break from Ogden to Lucin. While the work of filling in the temporary trestles was still in progress, early in 1904, the operation of freight trains over the partially completed cut-off was commenced.

It is of interest to note that the filling in of the western approach between June 2 and Dec. 12, 1903, proceeded at the average rate of 14,625 cu. yds. per day.

The profile grade of the permanent trestle was El. 4217, and from each end of the permanent trestle the grade ran down to El. 4212 at the rate of 0.1%. The surface of the water in the lake at this time averaged El. 4200, and the depth in the vicinity of the permanent trestle was 20 to 30 ft.

No difficulty was experienced in making the embankment of the approach east of the permanent trestle, but the soft mud forming the bottom of the lake from near the west end of the permanent trestle as originally planned to within about two miles of the shore was causing trouble by allowing the dumped-in material to sink, throwing the temporary trestle out of line. Also, when the embankment had been brought up to grade and the trestle stringers had been removed, it continued to sink, especially when loaded by a train of 47-yd. gravel cars.

Anticipating great difficulty and expense, therefore, in constructing the embankment of increasing height near the west end of the 11-mile permanent trestle, at the recommendation of the late Mr. W. E. Marsh, Assistant Engineer of the Southern Pacific Co., in charge of the construction of the cut-off, the plans were changed by Mr. William Hood, Chief Engineer, in January, 1904, extending the permanent trestle 3,000 ft. westward.

The problem of driving the piles for the permanent trestle extension with a minimum amount of delay to the freight traffic was solved successfully by Mr. B. S. Roberts, Superintendent of the Trestle Construction on the cut-off. A skid driver working on the trestle would have effectually blocked all traffic, and a scow driver is not adapted to driving trestle-bent piles from the side of the trestle. A car driver could have done the work perhaps, but would have been employed in actually driving piles a few hours only each day on account of having to take a siding one to two miles west of the work to let traffic pass.

The "roller case" pile-driver was, therefore, designed by Mr. Roberts, to operate along the side of the temporary trestle on a low falsework consisting of two-pile bents, piles 24½ ft. c. to c., and bents 15 ft. c. to c., capped and connected up by 8 × 17-in. × 30-ft. trestle stringers. This driver and its falsework are shown by drawing in Fig. 1, and in photograph by Figs. 2 and 3.

Briefly described, the framework of the driver consisted of stationary gins, built of two 6 × 10-in. × 57-ft. pieces of Oregon pine, framed so as to set at a proper batter to bring the king pins directly over the center of the trestle and 33 ft. above the cut-off (pile) elevation. These stationary gins were rigidly held in place by two 4 × 6-in. 55-ft. backstays, 4 × 6-in. [illegible] and two ¾-in. wire cable guys as sh[illegible]. The swinging gins were constructe[illegible] 8-in. × 52-ft. pieces of Oregon pin[illegible], 6 × ¼-in. strap iron, and framed so [illegible] ins. apart face to face of irons. The[illegible] also reinforced with 6 × 8-in. × 4[illegible] bolted to them as shown by a detai[illegible] Fig. 1. The swinging gins were hi[illegible]

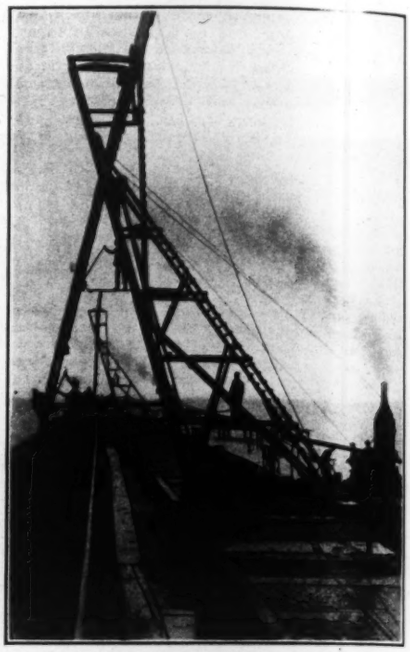


Fig. 2. Driving Outside Batter-Piles, Trestle Extension of Ogden-Lucin Cut-Off.

inside of the stationary gins by means of two 2½-in. king pins set in two sets of swivel irons, and further guided in swinging by two 1½-in. pins sliding on a 3 × ¼-in. strap iron bolted to the upper surface of the moon beams, as shown in the side elevation and detail in Fig. 1. This strap iron was bent to a curve of 14½-ft. radius

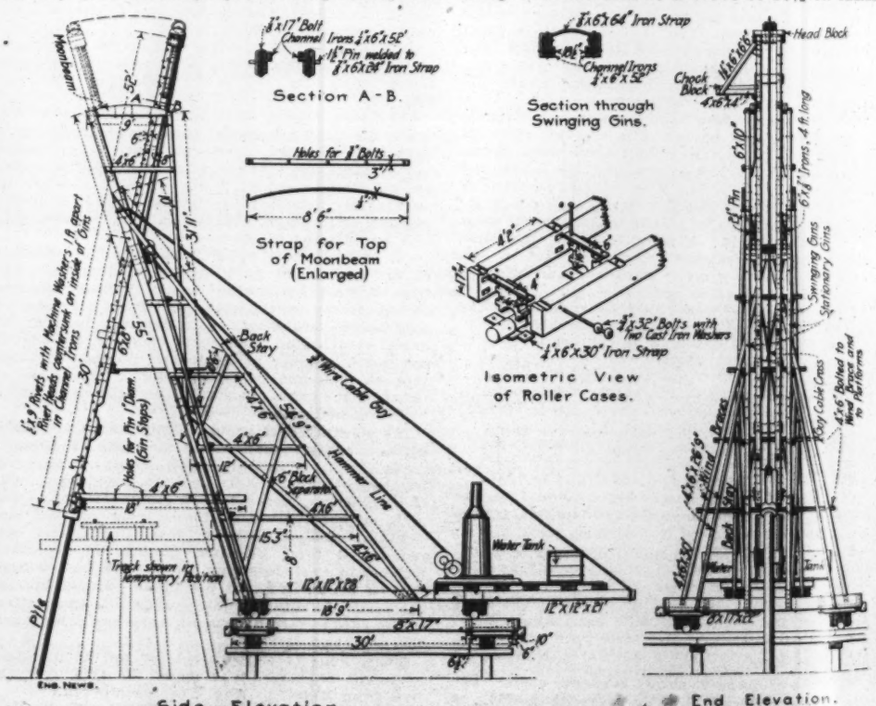


FIG. 1. DRAWINGS OF "ROLLER CASE" PILE-DRIVER FOR WORK ON OGDEN-LUCIN CUT-OFF, SOUTHERN PACIFIC CO.

*Construction Department, Southern Pacific Co., 234 Iowa St., San Francisco, Cal.

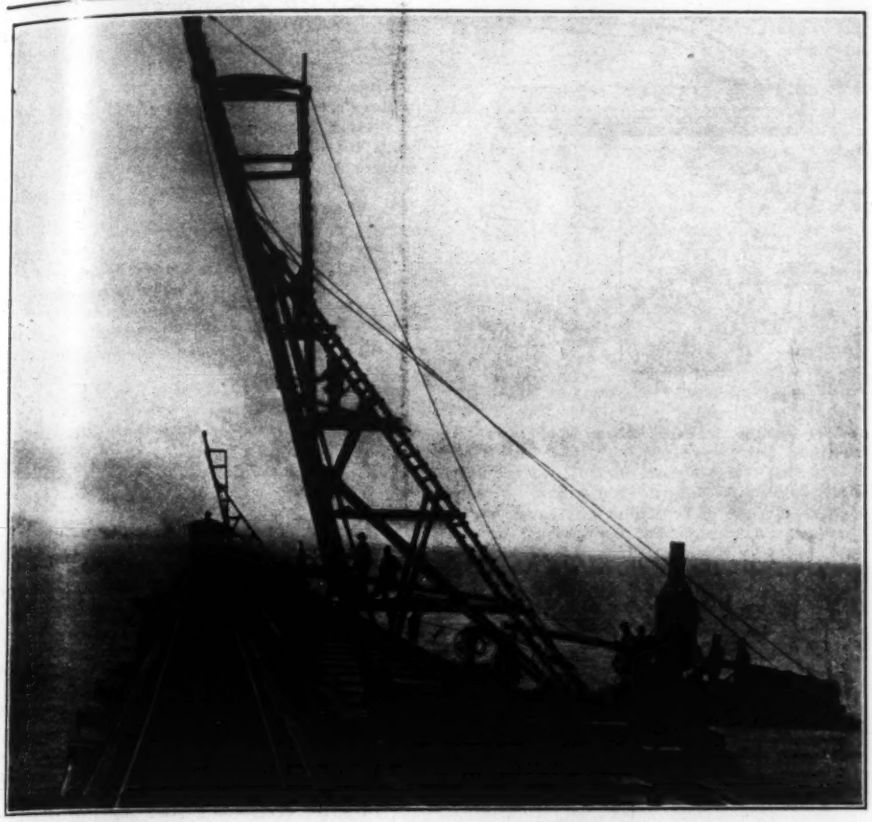


FIG. 3. THE ROLLER CASE PILE-DRIVERS SWUNG BACK FOR PASSAGE OF A FREIGHT TRAIN.

and each end was bent upwards so as to prevent the gins from going too far in either direction. The swinging gins were held in their proper positions for driving the five piles of the bents by two 4 × 6-in. × 18-ft. planks bolted to the bottom of the swinging gins, and extending over to a cross-brace on the stationary gins. These planks were bored with five holes properly spaced, so that by placing a 1-in. pin in the hole over the lower cross strut of the stationary gins, the swinging gins were securely held as desired.

Two sets of four rollers each, and operating at right angles to each other, were set under the sills of the driver; the lower set to allow the driver to be moved longitudinally on the falsework, parallel to the trestle, and the upper set, at right angles to the trestle, to place the driver entirely in the clear of passing trains. The rollers, 10 ins. in diameter and 6 ft. long, were made of oak and were set in "cases" made up of two 8 × 17-in. timbers, 30 ft. long for the lower rollers and 22 ft. long for the upper set. Several 1-in. holes were bored in the projecting portion of the rollers, so that a final adjustment of the position of the driver could readily be made by inserting bars and turning the rollers by hand.

Two drivers, as described above, were constructed and they made satisfactory and excellent progress, as well, in fact, as that made by any one of the dozen or so skid drivers that were employed in driving the original permanent trestle. The driving of the 3,000-ft. extension by these two drivers was completed in about two months' time.

Fig. 2 shows the near driver driving an outside batter pile. Fig. 3 shows a freight train about to pass the two drivers, the swinging gins of each being swung back between the stationary gins, and the drivers themselves rolled out to clear.

The physical conditions that make the "roller case" driver, as described in this article, best adapted to the work, are shallow water, so that reasonably steady falsework may be cheaply constructed, and soft ground, so that the driving will not be hard.

Light on a Civil-Service Trigonometrical Problem.

In our issue of May 4, 1911, p. 545, Mr. C. E. Harris, now City Engineer of Norwich, N. Y., submitted the problem illustrated by Fig. 1 herewith, which had been given in a New York State Civil Service examination for Assistant Engineer. Since that time we have had a number of solutions sent to us, and we take this opportunity of presenting them to our readers.

Of these solutions one was as follows: From the triangle ABC compute the side BC, and from the triangle ABE the side BE, by the law of sines. We now have the three-point problem with D the point to be located, having given the three fixed points C, B and E, and the angles to them from D.

The most convenient form of the three-point formula is:

$$\cot x = \cot R \left[\frac{a \sin P'}{b \sin P \cos R} + 1 \right]$$

in which, in this case, $x = \angle DEB$,

$R = \angle DEB + \angle DCB$,

$= 360° - (\angle CBE + \angle CDB + \angle BDE)$,

a = the distance BE,

b = the distance CB,

P' = the angle CDB, and

P = the angle BDE.

In the problem as given by Mr. Harris, it was not stated whether text-books would or would not be allowed. However, the three-point problem

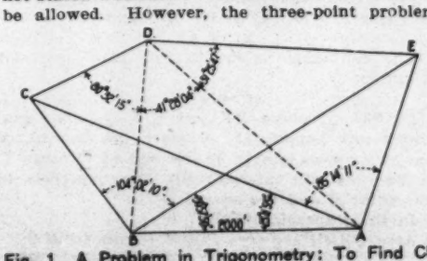


Fig. 1. A Problem in Trigonometry: To Find CD and DE in about One Hour's Time.

is so common that the formula is likely to be remembered, or it may be easily derived in a very few minutes by applying the law of sines.

Having found the angle x or DEB and the angle DCB, the triangles DEB and DCB are easily solved by the law of sines for the sides DE and CD, respectively; which completes the problem. (Submitted by Mr. John H. Beck, Worcester, Mass. Time required was about one hour. The same method was sent in by Mr. E. A. Shafer, Narrows, Harney County, Ore., whose solution includes the derivation of the formula. He gives no numerical results and states no time. Mr. M. H. Fogelstrom, San Francisco, Cal., also worked out the formula, reaching the solution by the same general course. Time required, 63 mins.)

Another solution by the three-point problem method was by first finding the distance AE by the law of sines from the triangle AEB, and then using the three fixed points B, A and E. The solution of the three-point formula gives the angle AED. Solving the triangle AED gives the side DE. The angle DBA of the three-point quadrilateral determines the angle CBD, hence the triangle CBD is easily solved for CD. (Solution submitted by Mr. Frederic H. Martin, Rahway, N. J. Time required 1 hour and 10 minutes. Practically the same method was outlined by Mr. Edward B. Whittlesey, New York City, who suggested that the real difficulty in such examinations was the problem of dividing one's time most economically. A solution in a very similar manner was given by Mr. Lee Perkins, Globe, Ariz., which required but 39 minutes, but with erroneous results.)

An original solution was as follows: Having found the distances CB and AE the right-angle triangles of which CB and AE are hypothenuses were solved for the two legs of each. It was found that CE was parallel to AB and its length was determined. By extending the line DB to a point O, which is on the circumference of a circle passing through the points C, D and E, the lengths of OC and OE were found by a

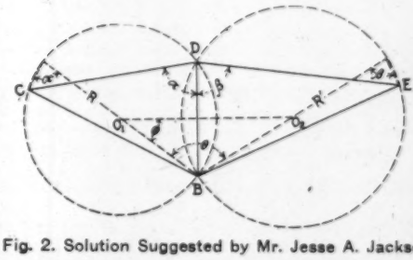


Fig. 2. Solution Suggested by Mr. Jesse A. Jackson.

series of trigonometrical and geometrical relations, and by a similar process—which we recommend to our readers who are rusty in mathematics and wish to brush up—the angles DCE and DEC were found; then by solving the triangle DCE, the sides CD and DE were determined. (Solution submitted by Mr. Simon Arken, New York City; time not given.)

Another original solution is illustrated by Fig. 2. In this case the distances CB and BE were first found and the radii of the circumscribed circles determined by the formulas $R = \frac{CB}{2 \sin \alpha}$ and $R' = \frac{BE}{2 \sin \beta}$ (Fig. 2), which are easily proved by inspection. The relation $\angle CBE = \theta + (90° - \alpha) + (90° - \beta)$, or $\theta = \angle CBE + \alpha + \beta - 180°$ is also known. Hence in the triangle BO_1O_2, we have known the two sides R' and R and the included angle Θ, from which the angle ϕ may be computed. Now the angle $CBD = (90 - \alpha) + (90 - \phi)$, and the angle $DBE =$ angle $CBE -$ angle CBD; hence the triangles BCD and BDE are solved for CD and DE. (Solution submitted by Mr. Jesse A. Jackson, Assoc. M. Am. Soc. C. E., Chief Computer in the office of the City Engineer, Seattle, Wash. Time required to devise method and make solution 65 minutes.)

A similar solution was submitted in which AD was taken as the common side in the triangles

ADE and *ACD*, solving for the angle *AED*. The unknown angle *ACD* was found in terms of *AED* from the known relation that the sum of the angles of the polygon are equal to 540°. (Submitted by Mr. Geo. W. Bates, Lincoln, Neb. Time required 45 minutes, using seven-place log tables. Almost the same method was submitted by Mr. Fremont Crane, Oahu, H. I. Time required slightly over 1 hour.)

The same general method was given in another solution in which *DB* was taken as the common side of the triangles *BCD* and *ABD*. Equating these expressions of *DB* a value was found for cot *DAB*, whence the angle *DAB* and the other angle of the quadrilateral *ABCD* were found. The distance *DE* was then computed from the triangle *ADE* and *CD* from the triangle *ACD*. (Submitted by Mr. John P. Newton, Assoc. M. Am. Soc. C. E., Albany, N. Y. Time required "less than 1 hour." Almost the same method was given by Mr. Mark Doran, New York City. Time required "less than 1 hour.")

A quite similar method involving only the law of sines applied to known sides and angles deduced an expression in which the angle *CBD* was the only unknown. The equation derived was for the tangent of this angle, which, when found, makes the determination of *CD* and *DE* easily accomplished. (Submitted by Mr. Meyer J. Soloman, New York City. Time not given.)

A further novel solution was as follows: The rectangular coordinates of the points *C* and *E* with relation to *B* or *A* and side *BA* were computed. From these *CE* was found parallel to *AB* and its length determined. The center of the circle through the points *A B* and *D* was next found, from geometrical relations the coordinates of its center with relation to the points already determined were computed. The center of the circle through the points *C*, *D* and *E*, and by a similar process its coordinates were next found. The point *D* is thus common to both circles, and the triangle formed by *D* and the centers of the two circles is easily solved. The coordinates of *D* were then found. The coordinates of *E* and *C* having already been determined the computations of *DE* and *CD* are easily made. This method is somewhat long and complicated, there being about 17 separate problems to solve, but the results obtained are very complete, making checking easy. This particular problem is somewhat simplified because *CE* and *AB* are parallel. (Submitted by Mr. Edward Godfrey, M. Am. Soc. C. E., Pittsburgh, Pa. Time required over an hour.)

The values of the computed distances from the various contributors, which, however, are not arranged in the order above given, are as follows:

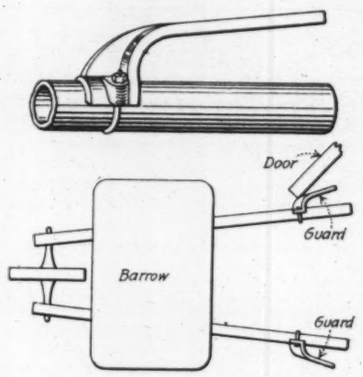
CD =		*DE* =	
	1264.91 ft.		2828.43 ft.
	1264.4		2829.1
	1264.85		2828.45
	1264.92		2828.43
	1264.918		2828.429
	600.557		3568.14
	1264.93		2828.92
	1264.913		2828.433
	1264.366		2825.588
	1309.0		2798.3

Four other contributors outlined methods without giving a solution for the specific case.

We cordially recommend to our readers a study of the above problem and the methods here outlined for solving it. It is a practical problem and will furnish an instructive and entertaining evening's pastime.

A Finger Guard for Wheelbarrow Handles.

Anyone who has ever barked his knuckles on some solid object while pushing a wheelbarrow will appreciate the merits of the simple device shown in the accompanying illustration. A steel or malleable-iron casting of the form shown is attached to the wheelbarrow handle at the desired position by a ⅜-in. U-bolt. The casting is made about 6 ins. long, 2 ins. wide at the base tapering to 1¼ ins. at the point and ¼-in. thick. It is curved to stand out 2⅛ ins. from the handle and is strengthened at the curve by a ⅜-in. rib. In operating the barrow, the hands are placed close up under the guard. Any blow against a nearby object caused by the swerving or tilting of the barrow will then fall on the guard casting instead of on the operator's knuckles.



A Finger Guard for Wheelbarrow Handles.

It is suggested in the "Journal of Industrial Safety," from which the illustration is reproduced, that the guard is of particular service when wheelbarrows must pass through a doorway, especially where the door is to be kept shut by means of a spring or weight.

A Simple Instrument for Measuring Areas.

By GEORGE MUNTZ.*

A little instrument devised by Mr. G. Beauvais, of Paris, France, though of extremely simple form, is admirably adapted for the measurement of plane surfaces of odd shape, for which usually the planimeter alone is available. This instrument is called by its inventor the "hyperbolic triangle" and the theory and practice of its use are described in the accompanying article.

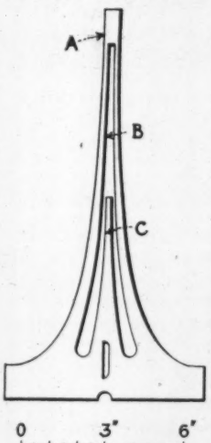


Fig. 1. The Hyperbolic Triangle; An Instrument for Measuring Areas. (Made by G. Beauvais, Paris, France.)

Fig. 1 represents a simpler form of the instrument, a thin copper plate from which two equilateral hyperbolas have been cut. If this instrument be slid along a straight line, as in Fig. 3, the areas included between the successive dotted lines there shown, dropped perpendicularly to the base from the points where the opposite sides of the "triangle" cut the irregular upper line, each equals a constant, which in the instrument shown is 20 sq. cm. Similarly, in Fig. 4, the area of each of the triangles included between the center point and any two adjacent cross lines on the perimeter is 10 sq. cm.

Theory of the Instrument.

It is a property of the equilateral hyperbola, that if the asymptotes are taken as axis of a rectangular system of coordinates, the product of the abscissa and ordinate of any point in the curve, is equal to the product of the abscissa and ordinate of any other point in the curve. In other words, this product is a constant, and the property can be put under the form:

$$xy = K^2.$$

The conjugate hyperbola will then have for equation:

$$xy = -K^2.$$

In Fig. 2, where *MY* and *M'Y* are conjugate equilateral hyperbolas, consider the portion of the two curves located on one side of the axis *X*. A line *DE* will intersect the first hyperbola in the point *M* and the second *M'*.

In the trapezoid *PMM'P'*,

Area *PMM'P'* = area *POQM* + area *OP'M'Q*.

Area *POQM* = area *OPMR* − area *QRM* = K^2 − area *QRM*.

Area *OP'M'Q* = area *OP'M'R'* + area *QR'M'* = K^2 + area *QR'M'*.

Then:

Area *PMM'P'* = $2K^2$ + area *QR'M'* − area *QRM*.

The area of the trapezoid is then equal to $2K^2$ plus the difference of the areas of the two triangles, *QR'M'* and *QRM*.

It can now be demonstrated that in practice the difference:

$$\Delta = QR'M' - QRM$$

is negligible, in other words, that $2K^2$ is near enough to *P'M'MP* to be considered as equal to it.

In doing so there is a slight error committed, which can be figured as follows: In Fig. 2, let $OQ = p$ and let m = the angular coefficient of *ED*.

$$\Delta = \frac{p}{4m}\left[\sqrt{p^2 + 4mK^2} - \sqrt{p^2 - 4mK^2}\right] - K^2.$$

This may be developed into the series:

$$\Delta = \frac{1.3.2^2.m^2}{|3}\cdot\frac{(K^2)^3}{p^4} + \cdots\cdots$$

$$- \frac{1.3.5\ldots(4n-1)\,2^{2n}m^{2n}}{|2n+1}\cdot\frac{(K^2)^{2n+1}}{p^{4n}} + \cdots\cdots$$

As the instrument is built so that

$$p^2 > \sqrt{70}\,K^2 m$$

it can be figured that this series is rapidly decreasing and that the first term is approximately 9/10 of the value of the series.*

Consequently it is sufficiently correct to state that

$$\Delta = \frac{1.3.2^2.m^2.(K^2)^3}{1.2.3.p^4} = 2(K^2)^3\frac{m^2}{p^4}$$

Which in any case within the range of the "triangle" is very small.

For instance, assume

$K^2 = 10$ sq. cm. (The standard of the instrument shown in Fig. 1.)

$m = 1.$

$p = 15$ cm.

then $\Delta = \dfrac{2{,}000}{15^4}$ = about 0.04 sq. cm.,

a very small quantity.

This proves that $2K^2$ can be considered as approximately the area of the trapezoid *PMM'P'*. This remains true for any position of *ED*, provided that the segments determined on the curve are of such length as determined below.

In Fig. 2, let $MM' = l$ and *OS* perpendicular to *MM'*. We have

$$OS = \frac{-p}{\sqrt{1+m^2}}$$

and inasmuch as

$$OS \times l = 2 \text{ areas } OMM' = 2K^2$$

we can write:

$$\frac{p^2}{1+m^2}\,l^2 = 4K^4$$

or

$$p^2 > \sqrt{70}\,mK^2 \qquad (A)$$

or

$$p^4 > 70\left(\frac{2mK^2}{2}\right)^2, \text{ it is easy to see that}$$

$$\left(\frac{2mK^2}{p^2}\right)^2\cdot\frac{35}{20} < \frac{1}{10}$$

or

$$\frac{u_2}{u_1} < \frac{1}{10}$$

which proves that the triangle being constructed to satisfy (A) the second term of the series is smaller than 1/10 of the first one.

*50 Church St., New York City.

*The reason of this is as follows: If u_1 is the first term of the series Δ and u_2 the second we have

$$\frac{u_2}{u_1} = \frac{(2mK^2)^2}{p^4}\cdot\frac{35}{20}$$

If

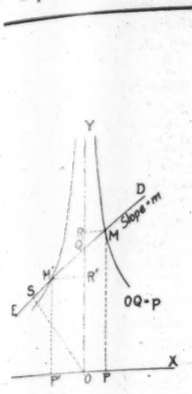


Fig. 2.

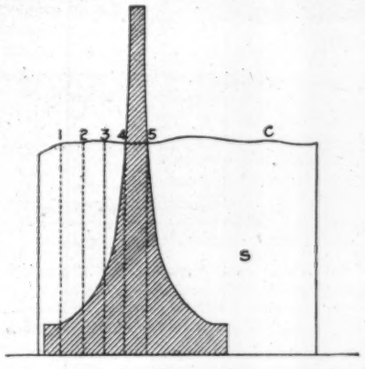


Fig. 3.

$$p^2 = \frac{4K^4}{l^2}(1+m^2)$$

If we substitute this value of p in Δ we have:

$$\Delta = \frac{2K^6 m^2 l^4}{16(1+m^2)^2 K^8} = \frac{l^4}{8K^2}\left(\frac{m}{1+m^2}\right)^2$$

This expression reaches a maximum at the same time as $\left(\frac{m}{1+m^2}\right)$ the derivative of which $\frac{1-m^2}{(1+m^2)^2}$, equals zero when $m = \pm 1$. Therefore with $m = 1$ we have for a maximum Δ.

$$\Delta = \frac{l^4}{32K^2} \qquad (1)$$

Substituting in (1), it is then easy to see that if the "triangle" is to give an error smaller than say 1/200, l should always be smaller than 2 cm.

In resumé; to obtain a sufficient approximation with the triangle, the length of the segments should never exceed 2 cm., and to get that maximum the distance of the bounding line should be more than 10 cm. from the origin.

In Fig. 3, if the instrument is slid along a straight line, the surface S will be divided into trapezoids of equal areas, each of them being equal to $2K^2$ sq. cm. If the divisions marked on C are smaller than 2 cm., the formula (1) gives us:

$$\text{error} < \frac{1}{200}.$$

If n is the number of trapezoids:

$$S = 2nK^2.$$

Instead of having the two hyperbolas slide along a straight line they can be turned around a common center, dividing the area S into equal triangles.

Use of the Instrument.

Suppose that it is desired to figure the area of a surface limited by a closed curve. The apparatus bears a notch which allows to swing it around a tack driven inside of the area (Fig. 4). Place the "triangle" in any initial position and mark the point 0 from which to start. Then with a sharp pencil mark off the point 1 where the opposite edge of the triangle cuts the curve and count one. Then swing the apparatus in such a manner that the branch of hyperbola which was in contact with 0 comes in contact with 1 and mark off the new division 2 and count two. The same operation is repeated until 0 is again reached after counting n. The whole area has been divided into n equal triangles having each a certain known area. The apparatus is constructed so that these triangles have an area of 10 sq. cm. The area is then:

$$S = n \times 10 \text{ sq. cm.}$$

As a matter of fact, it is seldom that the measurement comes back exactly to the point 0, and it is then necessary to add to the area of the $(n-1)$ triangles the area of the remaining small triangle, which can be determined by comparison.

The tack can be driven in any point in the interior of the curve, provided that no tangent can be drawn from that point to the curve.

USE OF THE INSIDE CURVES. — The apparatus bears four inside curves which permit the division of the remaining segment into four equal parts and make it easy to figure the ratio of the remaining portion to the unit.

The polygon determined inside of the curve is usually coincident with the curve, but in certain cases the coincidence is not perfect, and the inside curves provided on the apparatus have to be used. The hyperbola B determines divisions one-half of the ones determined by A. Thus when using A, after counting 17, when B is used the count will be 17½, 18, 18½, etc., adding only one-half for each new division.

When using C, add only one-fourth for each new division. The final area will then still be $(n \times 10\text{cm}^2)$. In no instance shall the divisions exceed 2cm.

Practically the degree of approximation is a function of the care taken in making the measure. The approximation varies from 1/200 to 1/500, and an odd area of a square foot can be determined in a few minutes. The instrument is quick and accurate, and has the advantage over other planimeters of being simple and sure.

To Lay Off and Measure Angles Without a Protractor.

By J. J. CLARK.

The following method of laying off an angle is due to H. F. Blichfeldt. The demonstration is too long to be given here, but may be found in the February, 1897, issue of the "Engineering Journal of Leland Stanford Junior University."

The chief merits of the method are the extreme accuracy and ease of construction, and the fact that it readily solves the problem of dividing an angle into any number of equal parts or in any ratio. The method is easily remembered and is very rapid in application; it is more accurate than an ordinary vernier protractor. We will apply it to three cases: (1) to lay off a given angle; (2) to measure an angle; (3) to multisect an angle, in other words, to divide an angle into any number of equal parts.

(1) Suppose it is desired to lay off an angle of 44° 50′ from oa, in the accompanying cut.

With o as a center and a radius $oa = 60$ units, describe an arc afb. With a as a center and the same radius describe an arc cutting afb in b.

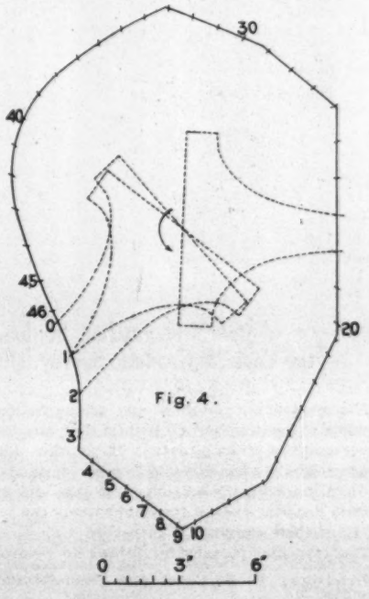


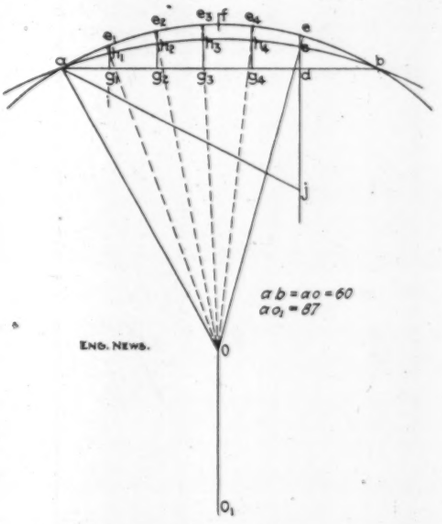
Fig. 4.

Draw chord ab and bisect it by the line fo. With a as a center and a radius equal to 87 units describe a short arc intersecting fo in o_1. With o_1 as a center describe an arc acb passing through a and b. Since $ab = ao$, ab is 60 units long. Consider every degree in the given angle to represent 1 unit; then 44° 50′ = 44⁵⁰/₆₀ = 44⅚ units. Lay off ad equal to 44⅚ units and draw dc perpendicular to ab, c being the point where the perpendicular intersects the arc acb. Draw oc, and aoc is the required angle.

If the given angle is greater than 60°, subtract 60° or multiples thereof until the remainder is less than 60°. Construct the angle so obtained and then add to it the amount subtracted.

(2) Let aoc be the given angle; to find the number of degrees in it.

Locate points a, b, and o_1 as before and draw arc acb. At c, which arc acb intersects oc draw cd perpendicular to ab; measure ad, and suppose



Method of Laying Off and Measuring Angles Without a Protractor.

that its length is 44.8 units, to the scale used. .8 unit = .8 × 60 = 48′, and the angle is 44° 48′.

(3) To multisect aoc.

To divide the angle into say five equal parts, determine the point d as in (2); then divide ad into five equal parts, determining the points g_1, g_2, g_3, and g_4. Draw perpendiculars through these points, intersecting arc acb in h_1, h_2, h_3, and h_4, and aoh_1 is one-fifth aoc. The easiest way to determine g_1 is: Produce cd downwards. Select a length on a scale that will be greater than ad, but the number of divisions of which will be a multiple of the parts into which the angle is to be divided. For example, suppose ad is about 3⅝ ins. long, and is to be divided into five equal parts. A distance equal to $5 \times (4 \div 5) = .8 \times 5 = 4$ ins. will be greater than ad. Lay the scale so that the zero mark is over a and the 4-in. mark falls on cd at f. The .8-in. mark falls at i, and a perpendicular to ab through i intersects ab at g_1 and the arc acb at h_1. Of course the equal arcs occur on afb.

The maximum error incurred in laying off an angle by the method described in (1) is 0° 0′ 26″ and occurs between 23° and 24°; that is, for an angle between 23° and 24° the angle if perfectly constructed by this method would be 0° 0′ 26″ smaller than the true angle. If the radius of the arc abc be taken as 87.0274, a more correct value, the maximum error is 0° 0′ 22″.

A recent book on engineering drawing makes that statement that drawing ink that has been frozen is useless and should be thrown away. Certain experiences in railroading in the Montana Rockies in the winter time lead us to doubt this statement, and cause us to wonder if it has been the custom of draftsmen generally. Suggestions from engineers on the conservation of drawing ink in a tent in winter might be interesting.

A Steam-Hammer Pile-Driver Diagram.

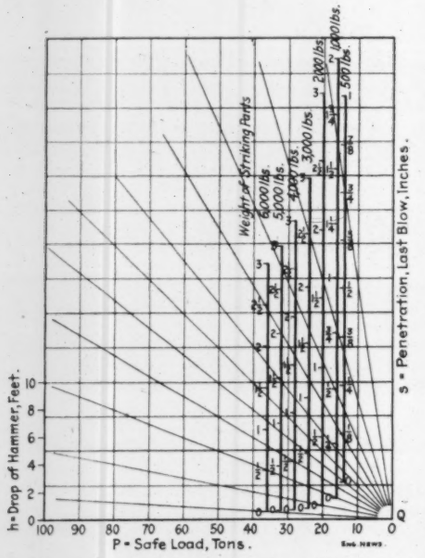
In our issue of Feb. 2, 1911, p, 139, we reproduced a diagram devised by Mr. Arthur S. Milinowski, Assistant Engineer, New York State Barge Canal, Brockport, N. Y., for determining the safe load on piles driven by a drop hammer. Mr. Milinowski now sends us a similar diagram for use with steam-hammer driven piles.

It is based on the Engineering News formula*

$$P = \frac{2\,wh}{0.1 + S}$$ where

P = the safe load on pile in tons,
w = the weight of hammer, in tons,
h = the height of fall, in feet,
S = the average penetration in inches for several blows.

On the diagram are scales representing the safe load, fall of hammer and penetration: the weights for hammer are given between 0.25 and 3 tons. In using hammers which depend upon steam pressure for a portion of their driving force, Mr. Milinowski suggests that the downward steam pressure must be added to the weight of the striking parts.



A line connecting point Q with the intersection of coordinates h and P passes through the corresponding penetration, as given by the formula:

$$P = \frac{2\,w\,h}{0.1 + S}$$

The Engineering News Formula for Safe Load on Piles in a Graphical Form.

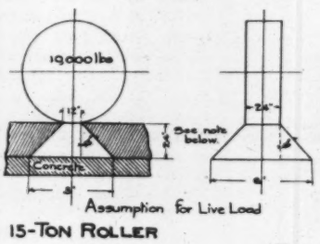
The diagram is ordinarily used to determine if a pile which showed a certain average penetration under the last few blows of a certain weight of hammer falling from a certain height, will safely bear the required loading. But any of the four elements, P, w, h or S may be determined if the other three are known.

The note under the diagram explains its use. The reader is referred to the previous diagram for any further explanation, and for caution in the use of this or any other pile formula.

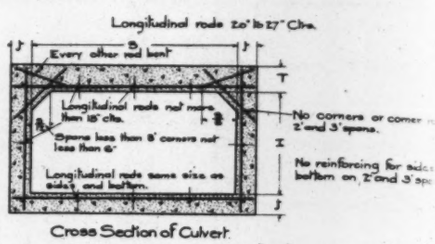
A Case to Hold Geological Survey Folios is described in the "Mining and Scientific Press" of Aug. 19, 1911. It is designed primarily for the geology folios. The folios stand on edge, requiring a depth of 21½ ins. and a height of 25 ins. The length of the case may be made as desired. Partitions are fixed at such spacing as to take half a dozen or more folios in each space; 1¾ ins. is recommended. In each space is a bottom strip to slide out, with a vertical ledge at the back as rear stop for the folios.

Such a cabinet is not required for the topographic sheets alone. As these sheets are used in much larger numbers than the geologic folios, satisfactory filing arrangements for them are correspondingly more important. Rolled up, they are practically useless.

*For discussion (by the late A. M. Wellington) of this and other formulas for safe loads on piles, see Eng. News, Nov. 17, 1892.



15-TON ROLLER


Longitudinal rods 20 to 27" C.to.
Every other rod bent
Longitudinal rods not more than 18" c.to.
Spans less than 8' corners not less than 6"
Longitudinal rods same size as sides and bottom.
No corners or corner
2' and 3' spans.
No reinforcing for sides bottom on 2' and 3' spa

Cross Section of Culvert.

TABLE FOR STANDARD CULVERTS

Loading 15-Ton Road Roller, 10,000 lbs. on each wheel.
Unit Stresses 16000 lbs. for Steel, 600 lbs. for Concrete, 0.7% of Steel
LOS ANGELES COUNTY HIGHWAY COMMISSION
A.E. Loder - Chief Engineer.

d-depth of fill H-height of culvert T-thickness of top t- " of bottom & sides S-span.				Top Reinforcement			Corner Reinforcement			Side Walls Reinforcement			Bottom Reinforcement			Quantities per lineal ft. of box		
d	H.	T	t	Size	Space	Length	Size	Space	Length	Size	Space	Length	Size	Space	Length	Cu. Yds. Con.	Steel lbs.	
0'	1'	4"	4"	⅜"	8"	2'-6"										.091	3.70	2'-Span
0'	2'	4"	4"	⅜"	8"	2'-6"										.115	3.70	
0'	1'	5½"	5"	⅜"	5"	3'-3"										.155	7.17	
0'	2'	5½"	5"	⅜"	5"	3'-3"										.186	7.17	3'-Span
0'	3'	5½"	5"	⅜"	5"	3'-3"										.216	8.12	
0'	1'	6"	5"	½"	8"	4'-8"	⅜"	16"	1'-6"	⅜"	16"	1'-9"	⅜"	16"	4'-8"	.204	12.83	
0'	2'	6"	5"	½"	8"	4'-8"	⅜"	16"	1'-6"	⅜"	16"	2'-9"	⅜"	16"	4'-8"	.235	13.55	4'-Span
0'	3'	6"	5"	½"	8"	4'-8"	⅜"	16"	1'-6"	⅜"	16"	3'-9"	⅜"	16"	4'-8"	.266	15.22	
0'	2'	6½"	5"	½"	7"	5'-8"	⅜"	14"	1'-6"	⅜"	14"	2'-9"	⅜"	14"	5'-8"	.278	17.91	
0'	3'	6½"	5"	½"	7"	5'-8"	⅜"	14"	1'-6"	⅜"	14"	3'-9"	⅜"	14"	5'-8"	.309	19.68	5'-Span
0'	4'	6½"	5"	½"	7"	5'-8"	⅜"	14"	1'-6"	⅜"	14"	4'-9"	⅜"	14"	5'-8"	.339	20.49	
0'	2'	7½"	6"	½"	6"	6'-10"	½"	12"	1'-9"	½"	12"	3'-0"	½"	12"	6'-10"	.373	23.23	
0'	3'	7½"	6"	½"	6"	6'-10"	½"	12"	1'-9"	½"	12"	4'-0"	½"	12"	6'-10"	.410	25.14	6'-Span
0'	4'	7½"	6"	½"	6"	6'-10"	½"	12"	1'-9"	½"	12"	5'-0"	½"	12"	6'-10"	.448	26.10	
0'	2'	8½"	6"	½"	8"	8'-10"	½"	16"	2'-0"	½"	16"	3'-2"	½"	16"	8'-10"	.494	38.32	
0'	3'	8½"	6"	½"	8"	8'-10"	½"	16"	2'-0"	½"	16"	4'-2"	½"	16"	8'-10"	.531	41.30	8'-Span
0'	4'	8½"	7"	½"	8"	9'-0"	½"	16"	2'-0"	½"	16"	5'-2"	½"	16"	9'-0"	.628	43.02	
0'	5'	8½"	7"	½"	8"	9'-0"	½"	16"	2'-0"	½"	16"	6'-2"	½"	16"	9'-0"	.671	46.00	
0'	2'	10"	7"	½"	6½"	11'-0"	½"	13"	2'-6"	½"	13"	3'-3"	½"	13"	11'-0"	.700	54.90	
0'	3'	10"	7"	½"	6½"	11'-0"	½"	13"	2'-6"	½"	13"	4'-3"	½"	13"	11'-0"	.742	58.17	
0'	4'	10"	7"	½"	6½"	11'-0"	½"	13"	2'-6"	½"	13"	5'-3"	½"	13"	11'-0"	.786	59.74	
0'	5'	10"	8"	½"	6½"	11'-2"	½"	13"	2'-8"	½"	13"	6'-4"	½"	13"	11'-2"	.900	63.90	10'-Span
0'	6'	10"	8"	½"	6½"	11'-2"	½"	13"	2'-8"	½"	13"	7'-4"	½"	13"	11'-2"	.949	65.47	
0'	7'	10"	8"	½"	6½"	11'-2"	½"	13"	2'-8"	½"	13"	8'-4"	½"	13"	11'-2"	1.000	68.74	
0'	8'	10"	8"	½"	6½"	11'-2"	½"	13"	2'-8"	½"	13"	9'-4"	½"	13"	11'-2"	1.048	70.31	
0'	2'	11"	8"	½"	6"	13'-2"	½"	12"	3'-0"	½"	12"	3'-7"	½"	12"	13'-2"	.916	69.31	
0'	3'	11"	8"	½"	6"	13'-2"	½"	12"	3'-0"	½"	12"	4'-7"	½"	12"	13'-2"	.965	72.71	
0'	4'	11"	8"	½"	6"	13'-2"	½"	12"	3'-0"	½"	12"	5'-7"	½"	12"	13'-2"	1.014	74.41	
0'	5'	11"	8"	½"	6"	13'-2"	½"	12"	3'-0"	½"	12"	6'-7"	½"	12"	13'-2"	1.063	77.81	
0'	6'	11"	9"	½"	6"	13'-4"	½"	12"	3'-0"	½"	12"	7'-6"	½"	12"	13'-4"	1.205	79.94	12'-Span
0'	7'	11"	9"	½"	6"	13'-4"	½"	12"	3'-0"	½"	12"	8'-6"	½"	12"	13'-4"	1.261	83.34	
0'	8'	11"	9"	½"	6"	13'-4"	½"	12"	3'-0"	½"	12"	9'-6"	½"	12"	13'-4"	1.316	85.04	
0'	9'	11"	9"	½"	6"	13'-4"	½"	12"	3'-0"	½"	12"	10'-6"	½"	12"	13'-4"	1.372	88.44	
0'	10'	11"	9"	½"	6"	13'-4"	½"	12"	3'-0"	½"	12"	11'-6"	½"	12"	13'-4"	1.427	90.14	

Note: This table is calculated for a minimum fill of 8 inches of rock over culvert slabs and is correct for all fills up to 6ft. in height.

Standard Culverts of the Los Angeles County Highway Commission.

The accompanying table, which we reproduce by the courtesy of Mr. F. H. Joyner, Chief Engineer of the Los Angeles County Highway Commission, contains data on the size, reinforcement, and quantities of steel and concrete per lineal foot of culvert, for the rectangular reinforced-concrete culverts now used on the county roads of Los Angeles, Cal.

The accompanying illustration shows the method of placing the reinforcement and the standard form of loading. The table is self-explanatory and will prove of value to those engineers who are engaged in highway improvement work as an example of practice on first-class roads.

Recovery of Old Triangulation Stations on the Coast & Geodetic Survey.

By N. H. HECK.*

The geographic value of any triangulation depends on the number of points that can be recovered at a future date. If at the time of executing the triangulation good methods are used in marking the stations and care and exactness is used in writing the descriptions the probability of their recovery is increased.

The principal reasons for failing to recover old stations are: 1. Changes due to man; as, the erection of buildings which cover the point; quarrying of the rock in which the mark was placed, or (in soft ground) excavations for various purposes; cultivation of the ground, in the course of which the mark may have been lost; and in some cases the stealing of the mark. 2. Changes due to nature; the rock may have crumbled or weathered so that the mark has disappeared or become undistinguishable; trees used as reference marks may have rotted away, or the natural features may have changed so that the descriptions are misleading. The usefulness of a recovered point often depends on the growth of trees or the existence of buildings that obstruct the lines of sight.

Some instances in connection with the preliminary triangulation in connection with a hydrographic resurvey of a portion of the Maine Coast are given in the following. The manual of Directions for Field Work, furnished to all field officers of the Survey, has been drawn upon for some of the remarks.

The triangulation was executed in 1859, and so far as the records showed none of the points had been recovered since that time, though it is likely that some of them had been used in the meantime without the fact being reported. These stations were marked either with copper bolts set in the solid rock, a cross being cut in the top to give the exact point, or with drill holes in the rock, or (in soft ground) by granite posts or buried bottles. Marks having copper bolts were in

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all cases covered if the rock remained intact. The other types gave more difficulty.

In one case the point was marked by an iron bolt set in the rock, covered with soil a foot deep. This was covered by a small rock with a drill hole, and the distances to several drill holes in surrounding ledges were given. After several hours search one of the drill holes (the only one remaining was found, and from it a small boulder covered by brush was found, with a very evident drill mark. The bolt was found under this rock as described.

One description called for a spike on the highest point of a small island, 18 ins. beneath the surface. The island was found to be covered with sod, but piles of rock were found where a tripod signal had stood. Digging in the center of these resulted in finding a spike, lying in a crevice of the rock. This station was then more permanently marked.

At one station one of the fences of the description was missing. The most probable locality seemed to agree with an excavation where sand had been removed. On the edge of this a boulder with a drill hole was found which agreed well with the description, and a number of old wrought nails. This was considered sufficient evidence for reporting the loss of this station.

A hydrographic party apparently recovered a station marked by a drill hole and erected a signal, whose position agreed well in the plane-table work. Later triangulation showed a discrepancy, and the original point was found about 20 ins. from that first recovered. The drill hole had become filled with small particles of rock and the growth had covered it.

At several stations marked by a simple drill hole, cavities were found, any one of which might have been the desired one after 50 years of weathering. In such a case the determination of a flag in the vicinity is necessary to decide.

Frequently information can be obtained from natives, especially from older men who remember the original work. A station reported lost on account of a misleading description was later recovered by means of such information. Sometimes the information is indefinite or misleading. In one case the absence of a copper bolt from a drill hole was explained by a native as being due to lightning, though he failed to explain how the melted copper escaped from the hole.

For any such search after old stations, all of the stations are plotted on the largest-scale chart available; contours are of great value in reaching the locality. When the approach is through thick woods care is necessary, especially if the station is surrounded by trees. In one case a very careful search was made 600 ft. from the desired point, though later the point was recovered with ease.

In the survey partly described, 8 out of 15 stations were recovered at first attempt, but 3 of them were useless without extensive tree cutting. Five were lost because of improvements, and one because of crumbling rock. The others were drill holes, and further determination was necessary to verify their location.

It is now customary to remark all recovered stations, and to mark all the new ones in such way that they can be recovered again without difficulty and beyond all doubt. In solid rock copper bolts or special station marks are used for centers, and two to three reference marks (usually drill holes) are established at each station. The drill holes are frequently filled with lead, as even after weathering the oxidized lead will present a different appearance from the rock. In crumbling rock the broken surface is removed with drill or pick axe, and a granite or molded concrete post is set in cement which bonds it to the solid rock. In soft ground drain tiles filled with cement are also much used.

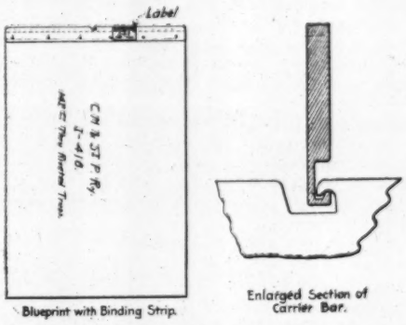
Capacity of Tanks.—Wm. Brown, Coatesville, Pa., asks for formulas or tables giving the contents of horizontal cylindrical tanks for different depths of liquid in the tank. They should cover both flat heads and dished (spherical segment) heads.

Hangers and Rack for Blueprints.

O. H. BASQUIN, M. W. S. E.*

Blueprints from the plans of a bridge or of a building are commonly bound together along a narrow end and have the other three edges neatly trimmed to a uniform size. For storage such sets of prints are rolled up, tied, labelled and stowed away in some dark closet; they are thereafter not easily found and it is an annoyance to refer to them because they refuse to lie flat when unrolled.

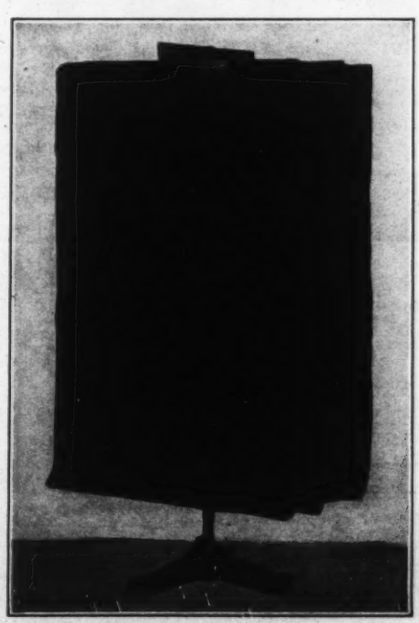
In an engineering office when any drawing



shows a new construction, or a specially good solution of an old problem, it is customary to send an extra print therefrom to the drawing room, where it is filed, with others of like nature, in an album of designs. These sets of prints are laid out flat, one on another, in large drawers; and when any draftsman is in difficulty he pulls out the set which is most likely to show how a similar problem has been solved by some other man. But when he comes to the drawer, the particular set of prints which he wants is not likely to be at the top of the drawer, and through this extra handling the sets of prints become mussed and torn.

For the storage of sets of prints the following plan is being tried at the College of Engineering at Northwestern University and promises to give satisfaction.

A separate hanger is provided for each set of blueprints. It is made from a strip of steel 2 ins.



wide, 1-16-in. thick and equal in length to the width of the set of prints; at its ends the corners are rounded. The prints are attached to the hanger by means of ordinary brass paper-fasteners, which pass through 3-16-in. holes made in the lower part of the hanger. At the middle of the upper edge of the hanger, a portion of the metal is cut out so as to form a small hook, shown to full size at the right Fig. 1. The hook is used in suspending the set of prints from some support such as a steel wire or a special rack. Since the hook is small and does not project above the upper edge of the hanger, it is not likely to catch on the coat sleeve of one who is using the prints. A card label of 1¾ × 3 ins. is attached to the hanger by means of shellac and on this label is entered the name of the set of prints. The device thus far described is shown or indicated in Fig. 1.

It would be possible to devise many forms of a rack suitable for use with these hangers. The one shown in Fig. 2 is simple. The rail upon which the hooks are hung is made from a bar of steel 2 ins. wide and ¼-in. thick, and a portion of its section has been cut out so that it has the form shown in Fig. 1. At its middle it is attached to the top of a vertical steel standard, the lower end of which is screwed into a cast iron base. About half of the sets of prints are placed on each side of the standard. They may be slid along the rail but not past the standard. Any one set may be taken out in any position and hung up again in the same or in any other position.

This device will generally occupy less floor-space than a case of drawers of equal capacity, it represents a very small investment, and every drawing is easily accessible. It is original with the writer, who does not intend to make application for patent.

*Professor of Applied Mechanics, Northwestern University.

Latitude and Time Determination by Star Photography.

Latitude and time determination by star photography is briefly described in a paper by Mr. Arnold Bombe in the July issue of the "Technologist," the monthly publication of the National Association of German-American Technologists. The method consists essentially of locating the zenith on a photographic plate, by one of the two methods given below, and scaling the difference in declination between it and a star whose declination is already known, which will give latitude; and finding the time when a known star crosses the meridian, for time correction (or longitude determination if a standard-meridian chronometer is at hand).

The method of procedure is as follows: Mount the camera on a horizontal plate, on which it is possible to turn off very accurately 180°, the camera pointing up towards the zenith. The position of the zenith on the plate may be determined by suspending two plumb lines on two adjacent sides of the camera, when the intersection of their images will give the zenith point; they should be placed so as to give nearly a right-angle intersection on the photographic plate. To make the exposure the strings are wet with some liquid so as to glisten, and illuminated by a strong light, as a bull's-eye lantern, for about 10 sec. Star tracks of the stars near the zenith are then obtained by making exposures of fixed length, followed by interruptions of fixed length; 2-min. exposures and 10-sec. intervals are suitable. These star tracks are used for the latitude and time determinations, but may also serve to give the zenith. For the latter purpose a short group of exposures should be made with camera turned 180° from its original position. The "reversed" group of exposures being made just halfway between the two sets of "direct" exposures, the middle points of the groups are connected by a straight line, which will pass through the zenith. Two different stars give two intersecting lines, whose intersection is the zenith.

To determine latitude it is necessary to find the declination of the zenith. From the Nautical Almanac or similar publication the declinations of the stars are known, and by measuring between two star paths a linear scale for angular declination is found for the plate, so that the difference in declination between the zenith and a star can be measured in arc, which enables the declination of the zenith and the latitude to be found.

To determine sidereal time at any instant it is

necessary to know the hour angle of the Vernal Equinox at that particular instant. To do this on the plate drop a normal from the zenith to any of the star paths. This is the meridian for the place of observation. The star path being broken by the intervals when the shutter was closed, and the clock time of these interruptions having been noted when the exposures were made, it is easy to measure at what clock time a particular star crosses the meridian. The right ascension of this star being known, the sidereal time of that particular clock time is obtained, and from it the local mean solar time found by adding the mean solar time of sidereal noon, from the tables. Comparison of this result with the clock is correct for a standard meridian, the difference represents the longitude of the place of observation.

Under the heading **"Gems From the Question Box,"** Mr. H. M. Phillips, of Pittsburgh, writes:

Sir: Although the writer is not prone to find amusement in or to ridicule anyone's honest endeavor to acquire knowledge the following queries noted many years ago in the columns of one of our technical (or semi-technical) journals have made a lasting impression on his mind. He feels no compunction in re-publishing them at the present time, for if the writers are still living and are readers of this paper their minds have surely broadened sufficiently to laugh at their early follies.

QUERY 1.—"Please tell me what is latent heat and how to cure warts."

The first part of the question was answered very satisfactorily; for the second the writer was referred, not to "Tom Sawyer" (or was it "Huckleberry Finn,") but to an earlier number of the same paper. Comment on this is unnecessary.

QUERY 2.—"The barometer in our school stands at 17 ins. instead of 26 ins. as it should. Please tell me what is the trouble and how to remedy it."

The state from which this inquiry was dated is not mountainous.

QUERY 3.—"Owing to recent heavy rains our cellar, which is below the sewer level, is nearly full of water; please tell me how to remove same."

Types of Standard Benchmarks in New York City.

In the establishment of a comprehensive series of standard benchmarks in New York City, which work has been in progress for two years past and is now nearly completed, the various forms of mark shown in the adjoining drawing have been employed.

MARKS ON BUILDINGS.—These are generally of the set-bolt type. The preferred location is in the vertical face of a wall, in which location, when the mark is set in flush with the face, it is secure against all disturbing agencies except actual settlement of the wall.

The preferred mark is a set bolt with a tablet head, as shown at A in the drawing. This is cast brass, the shank being turned to form the teeth. The mark line and lettering are depressed, being cut in the brass pattern and thus formed in casting. Two lugs on the back of the tablet give a bond against turning. These marks are usually leaded in, for which a small tin pipe is passed through a grooved enlargement of the hole around the tablet and along the shank to the back of the hole, and lead poured in to fill all openings, after sealing the front face with asbestos cement.

The amount of cutting of the stone for the tablet is inconveniently great when the stone is of a hard variety, and simple copper-bolt marks are more commonly used in granite. As used here they range from ½-in. to ⅞-in. diameter, and 2-in. to 3-in. length. Sketch B shows one of these marks. The shank is roughened by filled grooves and the back end is cut to spread against a steel wedge. Lead setting is preferred, but cement is sometimes used for the bolts as well as for the marks of tablet type. Lead is not used in the softer limestones. The bolts are set either in the wall or in the horizontal face of a step or window-sill.

Wherever a flush wall mark is set, a horizontal or step mark is placed nearby, as a secondary mark more convenient to hold upon. Sketches C and D show two cases. In the former the secondary mark is a copper bolt, while in sketch D it is a simple depression cut in the stone, as per sketch F. In the case sketched at E a window-sill bolt was set as primary mark.

A projecting form of wall bench was applied in a dozen or more locations as a special type. Sketch G shows the construction. The mark can be held on very conveniently. By making the mark of a solid piece of steel and shaping its nose to a bracket below, it is expected to be secure against accidental disturbance or violence. The steel was galvanized after shaping. Notches in the shank retain it in the lead filling.

GROUND MONUMENTS.—Marks set in the ground were detailed as copper bolts set in stone or concrete monuments, these in turn being held in a large block of concrete molded in place. The Coast & Geodetic Survey tablet mark, Sketch H, was used in a few instances. More generally, the types sketched in J and K were used, the former (molded concrete monument) in Brooklyn and the latter (stone monument) in Queens Borough. Iron protecting boxes cover the top, the mark being usually 4 to 6 ins. below the ground surface.

This benchmark work was undertaken by the Board of Estimate & Apportionment of New York City (Mr. Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer). It was organized as the Division of Triangulation & Precise-levels, with Mr. Frederick W. Koop as Engineer-in-Charge (26 Court St., Brooklyn).

Tests of Old Bridge Iron were made in the course of the replacement of the bridge over the Rhine at Cologne last year. The bridge was built in 1857-1861, and was closed in 1909. It carried a railway traffic ranging from 8 trains daily to 380 schedule trains daily. During the replacement the contractors, the Gutehoffnungshütte, took test-pieces from various parts of the bridge for tensile test, with results as follows:

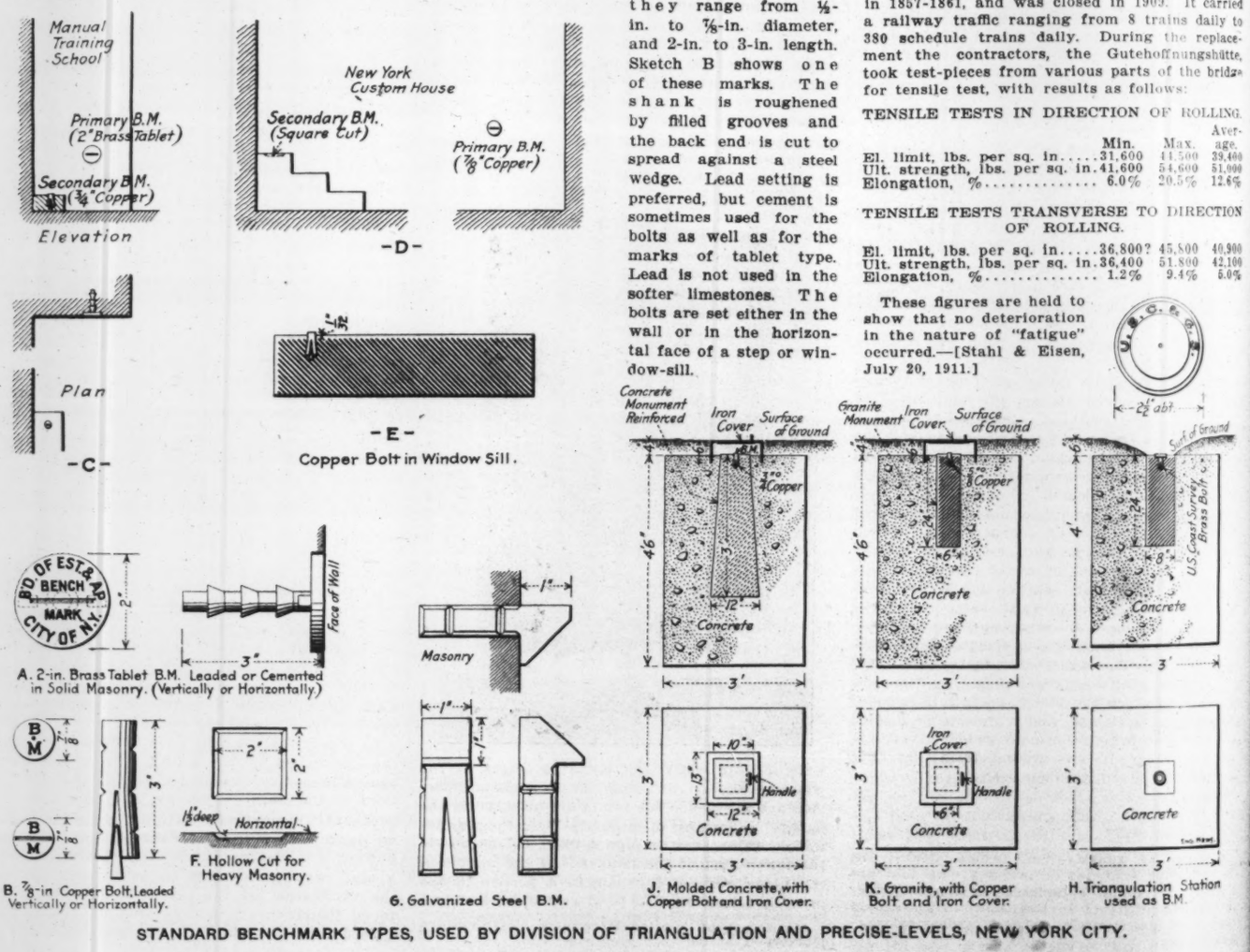
TENSILE TESTS IN DIRECTION OF ROLLING.

	Min.	Max.	Average.
El. limit, lbs. per sq. in.	31,600	41,500	39,400
Ult. strength, lbs. per sq. in.	41,600	54,600	51,000
Elongation, %	6.0%	20.5%	12.6%

TENSILE TESTS TRANSVERSE TO DIRECTION OF ROLLING.

El. limit, lbs. per sq. in.	36,800?	45,800	40,900
Ult. strength, lbs. per sq. in.	36,400	51,800	42,100
Elongation, %	1.2%	9.4%	5.0%

These figures are held to show that no deterioration in the nature of "fatigue" occurred.—[Stahl & Eisen, July 20, 1911.]



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The Compensation of Scientific Experts in Government Service.

In commenting on the extraordinary scheme to oust Dr. Wiley, the pure food expert, from the Government service, in our issue of July 20, we remarked that the matter of greatest public importance in the whole affair was that the Government is handicapped in conducting its scientific work by a law limiting the compensation which may be paid to any scientist employed to make original investigations to $3,500 per year as a maximum.

Along the same line, the following paragraph is of interest from President Taft's decision in the Wiley case, made public last week:

> The truth is, the limitations upon bureau chiefs and heads of departments to exact per diem compensations for the employment of experts in such cases as this is a doubtful legislative policy. Here is the pure food act, which it is of the highest importance to enforce, and in respect to which the interests opposed to its enforcement are likely to have all the money at their command needed to secure the most effective expert evidence. The Government ought not to be at a disadvantage in this regard.

We may add that the limitation fixed by Congress on the rate of annual salary is rendered ten times more burdensome by the ruling made by the Attorney-General that the limitation of the maximum salary rate to $3,500 per year fixes the maximum rate of pay per day at 1/365 of that amount. This ruling is so opposed to common sense and to universal custom in the buying and selling of professional and personal service that there is every reason to believe it would be upset if tested in the courts. Any man will be satisfied with a far smaller rate of daily compensation if working in a permanent position at an annual salary than he could at all afford to accept if given only occasional employment by the day.

In Mr. Wickersham's own bureau, the lawyers holding permanent positions, are paid a far lower rate per day for their time than is allowed to the special counsel brought into the Government service to try some particular case.

But it is bad for the Government's interests to have any cast-iron limit placed upon either the daily or the yearly rate of salary which may be paid to an expert in either science or law.

Congress must, of course, have control over expenditures; but the control should be exercised by allotting a lump sum to a Department or Bureau carrying on certain work. The responsibility is then upon the officers of that Bureau to spend as much of the appropriation as may be necessary to get the best results.

Some Good Roads Problems and Fallacies.

Where is the demand for good roads construction with borrowed money to stop? For many years Massachusetts and New Jersey raised annually by taxation modest sums in aid of road improvement. Other states followed suit until the practice became quite common. Making a "network of good roads throughout the state" was slow work at this rate, particularly in states of large area, much of which is sparsely populated. This slowness gave rise to impatience in some states, notably in those which were far behind some of the others in entering upon state aid to road construction. As a result, immense bond issues to pay for state road construction were advocated, and after some agitation they were secured. New York State was the first one to begin a huge indebtedness for road construction, and her example has now been followed by Maryland, Pennsylvania and California, while the fever is spreading in other states.

A review of what has been attempted and accomplished thus far in New York State was embodied in a recent speech at Syracuse, by Governor Dix. Although the speech had the political turn which seems to be well-nigh unavoidable when a governor is discussing the doings of a past administration of different political complexion, and showed a failure to understand some of the conditions under which good roads have now to be constructed, yet the governor's remarks are, nevertheless, an impressive summary of the cost of New York's "good roads" campaign. We quote from the speech as follows:

> By a vote of the people of this State there was authorized an expenditure of $50,000,000 for highway improvement. I think you should know the debit and credit side of this account. In 1907 a map was produced by the Legislature indicating a system of highways known as county roads, aggregating a total of 8,380 miles. In other words, after the authorization of this vast expenditure, it was determined by experts that 8,380 miles of improved roadways would be constructed. Subsequent to this determination another system of highways was established known as State roads, aggregating 3,055 miles, which has been increased to 3,494 miles, making a total of 11,000 miles to be made a direct charge against this $50,000,000 bond issue.
>
> To-day we find that when all the work under contract shall have been completed and paid for there will have been expended of the $50,000,000 bond issue $25,500,000, with the result that only 2,479 miles of the county roads will have been improved out of 8,380 contemplated, and only about 543 miles of the State roads out of the 3,494 miles contemplated.
>
> The average cost to the State of these improved roads has been about $9,000 per mile, not including the money which has been paid by the counties. The Legislature has appropriated in special acts $3,995,000 for certain State roads, which, added to the $25,500,000 already contracted for, makes a total of $39,455,000 expended and leaves approximately but $10,500,000 for distribution on a general allotment.
>
> It is evident that the distribution of expenditure for improving roads has not been made with the idea of completing roads on the map as approved by the Legislature in 1907 with the money provided. You will observe that 50% of the money has been obligated and only 25% of the mileage will have been completed, and, if I mistake not, another bond authorization will be demanded by the people to adequately meet the demands of agriculture and of trade and traffic.
>
> I was convinced that extravagance permeated the construction of these highways and county roads. There was no sound argument why State roads should cost exceeding $12,000 per mile and an additional cost for engineering greater than the engineering cost of important railroad construction, and it should not, if the public dollar purchases as much as the private dollar.

Very likely the people of New York will be called on for another $50,000,000 of bonds before the demands of the "good roads" advocates are satisfied. The question may well be asked, then, where is the "good roads" agitation to stop?

We shall not attempt to answer that question now. Instead, we wish to point out some fallacies in Governor Dix's statements and to call attention to a serious phase of the subject which he appears to have overlooked.

In the first place we have seen no evidence to show that a mere change in party control in New York or any other state will have any material effect upon either the apparent impossibility of resisting the demand for more and even more "good roads," built with borrowed money, or that mere changes in political control will result in greater economy of construction, or a better class of roads for the same money.

In the second place, can Governor Dix show that there ever was a well-planned scheme of road construction in New York State, which proved or attempted to prove that the various routes laid out could be built for $50,000,000, or any other stipulated sum? Can Governor Dix show for his own administration any careful and reliable estimates as to how many miles of "good roads" can be built with the funds still available?

Thirdly—to continue sermon-wise,—every engineer familiar with road construction knows that the cost of stone road construction has greatly increased in the last few years and that the heavy wear and tear of the automobile has made more expensive types of construction necessary.

Fourthly, the engineering cost of road construction is found to be more than that of many other classes of work, both public and private, because a given unit sum expended on country highways is distributed over a far greater distance than the same amount spent on railroad construction for instance. This, together with the special character of some of the work, requires heavier costs for supervision of highway work.

In saying all this we do not pretend to assert that there may not have been more or less unwise planning and more or less extravagance in the New York State road work, already done. What we do assert is that Governor Dix seems to rely on fallacious reasoning to prove his case against a previous political administration and to support his action in legislating the old highway commission out of office. It remains to be seen whether the new single highway commissioner, working in conjunction with the state engineer and state commissioner of public works, will build any cheaper or better roads than the three commissioners whose duties were confined to road building.

Finally, we call particular attention to the worst feature of the New York State road improvements, and one generally overlooked by all who discuss the subject. *These roads which Governor Dix claims to be extravagantly expensive in first cost, and which every engineer knows are but short-lived at best are being paid for by bonds which are to run for 50 years. In the present state of road building they will have to be renewed many times over, at least as to wearing surface, during the life of the bonds which are being used to pay for them.*

If Governor Dix wishes to take up a real reform, of lasting benefit to the people of New York, he would do well to address himself to this glaring evil.

More Friendly Comment from Abroad on Water Waste in New York City.

Our London contemporary, "The Surveyor," is so complimentary to our judgment in technical matters in New York City that we have yielded to the temptation of reprinting from its issue of Sept. 1 its further remarks on the subject, based on a note which appeared in our issue of Aug. 17, 1911. "The Surveyor" says:

NEW YORK'S WATER ADMINISTRATIVE DOCTRINE.

From the comments which Engineering News makes upon our remarks anent the administrative aspect of New York's waste of water, it would seem that American law admits of a situation which neither is, nor was, possible in any other country, except that of the Medes and Persians, in that "it altereth not." When once certain matters have been entrusted to a local authority, however blameworthy, the Government of the State, we are told, is powerless. We did not, in fact, suggest that the United States Government should intervene; but we assumed that if the city

officials defied the State, the force necessary to subdue them would not be withheld. In India the control of local affairs is sometimes taken bodily out of the hands of a persistently wrong-headed local authority. In the British Isles we have the administrative appeal, or the appeal to the courts. Very recently Parliament was prepared to sit during a part of the usual holiday period in order to settle a dispute between private employers and some of their workmen. The principle of an appeal, in grave matters, seems to be essential to the continuance of any State. There must not be citadels in which the will of the people as a whole is powerless. New York Municipality suggests a reversion to the castle of the robber baron of the Middle Ages, when the peasants of the country around paid heavy taxes. We wrote as we did because the attitude of Engineering News in this matter has been wholly reasonable and righteous, and we thought that had our contemporary made a stand in the last ditch the robber baron and his retainers would have been worsted. "Magna est veritas, et prevalebit."

In the same spirit of friendliness exhibited by "The Surveyor" we commend to its consideration for an exposition of the relations between our federal government and our state governments, on the one hand, and between our states and cities, on the other, that remarkably lucid work entitled "The American Commonwealth," by Hon. James Bryce, who now so ably represents Great Britain at the seat of our national government.

A "Field and Office" Supplement to Engineering News.

With this issue we begin the publication of what is expected to be a monthly feature hereafter—a "Field and Office" Section, to appear in the third issue of each month. As our older readers will recall, the monthly supplement to Engineering News devoted to "Engineering Literature" was established nine years ago, and has become well recognized throughout the engineering world as the place where new publications of interest to engineers are reviewed by experts with care and impartiality. Readers who follow this monthly supplement are enabled thereby to keep posted as to the new books and publications of importance and value to engineers.

The second of our monthly supplements, established two years ago, is devoted to the market prices of the materials used by engineers, and appears in the first issue of each month. This supplement has become a standard guide to engineers and contractors in making up estimates.

The third supplement, or section, the publication of which is begun in this issue, is to be termed the "Field and Office" Section. Its purpose is to give publication to the minor devices and methods used by the working engineer, either in survey work, in construction work or in the engineering office or drafting-room.

The main purpose in establishing this new department, we may frankly say at once, is to encourage our readers in all ranks of the profession to submit contributions describing the smaller things of interest and novelty which occur in their own work or which they see in use by others. We desire to emphasize the fact that these smaller matters are just as important to be placed on record as the great achievements of the men at the head of the profession. In fact these small details of everyday work are more directly useful to the rank and file.

It is true that such contributions as these have always been desired by the editors and have been sought for whenever information reached us concerning them. During the past history of Engineering News information has been given in its columns concerning a great number of such devices and methods. We consider this among the most helpful things and this journal has been able to do for the profession.

But it is also true, we realize, that many engineers suppose Engineering News, as a journal of high standing, does not care to publish the minor details of engineering work—that we seek the profound articles written by the great men of the profession and do not want to be bothered with the small matters of everyday work.

It is mainly to correct this too general impression that we have established this "Field and Office" Section. We wish here and now to assure our readers that there is a wide-open door in this office for every contribution describing any method or device which is not generally known and which, some engineer having found useful, other engineers similarly placed will also find of value.

Every engineer of experience knows that the success of every engineering work, whether it be in civil or mechanical engineering, mining or electrical work, depends first and last not only on the soundness of the general plan, but on the care with which a multitude of small details are looked after. In fact, it is probable that more failures in business and in engineering works have been recorded from lack of attention to details than from mistakes in the general plan.

Inasmuch as we have mentioned the fact that Engineering News desires contributions on these matters, it may be well to go a step farther and explain—what many engineers even now seem to be unaware of—that Engineering News pays for all original contributions which are offered exclusively to this journal and accepted for publication. Whenever a contribution offered is found unavailable for any reason, it is returned to the sender as promptly as possible to enable him to use it elsewhere if so disposed. While the amount of matter offered to us for publication is very considerably larger than the space available will permit us to accept, we are, nevertheless, always pleased to examine articles offered for publication as a larger choice for selection is thus afforded us.

It is hoped that the establishment of this "Field and Office" Section may especially serve to encourage our readers to submit *short* articles. There are probably a thousand or more of the readers of Engineering News who know of some small things which it would be of interest to describe in a brief way, and which could be done in a short article of 200 to 500 words, with perhaps one or two small sketches in the way of illustrations. We presume a goodly proportion of this assumed one thousand readers have said to themselves that some time, when they found leisure, they would write an article for Engineering News on this or that or the other thing. But in waiting indefinitely for time to write a long article, the short article which they could prepare in an hour or two is never written.

We do not say this to encourage the preparation of a quarter of a story when the whole story ought to be told. On the contrary, it very frequently happens that we delay the description of a piece of work or a device until sufficient information can be furnished regarding it to satisfy the reader when it is published.

The aim should be in describing a new device, for instance, to tell enough about it so that the reader who finds it of practical interest can judge whether the article is something that he ought to take up himself. In every such paper we aim to give either the author's name and address or the name and address of some party who can be relied upon to furnish additional authentic information to those who desire to follow the matter further.

In support of our statement that the new "Field and Office" Section is to contain matter which would have been welcome to Engineering News anyway, we have merely to point out that the present issue is made up from articles which were originally selected with a view to publication in Engineering News and have been merely classified under this head.

As to what we are to make of this "Field and Office" Section hereafter, we must say frankly again that this will depend upon the cooperation of our readers.

It is a source of great regret to us that the editors of Engineering News do not know everything! We regret, for instance, that we do not know the name and address of each of the thousand engineers who are doing just the thousand interesting things that we stand ready to publish descriptions of in this new department of the paper. If we knew their names and addresses, it would be easy to write a letter [illegible]ach man [illegible]rward to [illegible]pulling a [illegible]or work- [illegible]record of [illegible]ed pipe— [illegible]ar novel

giving him a personal invitation [illegible] us a description of this new way [illegible] refractory pile, or that useful sch[illegible] ing up an engine test, or this valu[illegible] the cost of laying a water main of [illegible] or each and every one of the pa[illegible] things that each man is doing.

But as, for obvious reasons, this [illegible]upossible, we trust our readers will each one, [illegible]se this as a personal invitation to contribute [illegible]ves from his own experience for the benefit [illegible]is fellow engineers as he has time and oppor[illegible]ity. The above suggestions are intended to m[illegible] him understand that *small* leaves may be [illegible] as valuable, and receive as much attention [illegible] that portentous thesis which he intends to [illegible]rite some time when he has the leisure, but wh[illegible], when he does write, may be too bulky any[illegible] for our columns.

It may not be amiss to say here a[illegible] that Engineering News is published for the instruction and aid of the *young* men in the profession much more than for those who have grown gray in the service who have perhaps lost some of their youthful enthusiasms and who are, we find sometimes, by their own confession, reading the popular magazines and general literature instead of engineering journals.

Of course, it is well understood that a technical journal ought not to give its space to such matter as is readily available in the standard text-books of engineering. Its function is to supplement the text-books; but the text-books are of necessity weak in the description of those small current details of practical work which are especially important to the success of the engineer up against practical problems. It is these details which we are striving to bring out for the benefit of the profession. With this appeal for the cooperation of our readers, we feel confident that a successful and useful future awaits the "Field and Office" Section of Engineering News.

LETTERS TO THE EDITOR.

The Comparative Designs of Reinforced-Concrete Floor Panels.

Sir: Referring again to the article on "Economical Design of a Reinforced-Concrete Panel" in Engineering News, Aug. 3, 1911, p. 133, and the letter on the same subject, in the issue of Aug. 31, 1911, p. 264, both by Mr. J. Norman Jensen, I beg to reply that I read Mr. Jensen's article very carefully and with much interest and that I did not overlook his statement that his comparative designs were based in general on the revised Building Ordinance of Chicago "in order to impose on each case the same general conditions of design."

I could not find, however, a provision in said Ordinance that the steel in a crosswise reinforced slab solved for $\frac{wl^2}{24}$ should be doubled, nor could I find formulas for the design of flat slab construction. This led me to the conclusion that Mr. Jensen had used his own judgment in these two cases and designed them according to what he believed to be right.

I called Mr. Jensen's attention to the fact that he contradicted himself by stating that a plate supported along its four sides is at least as strong as a plate supported at its four corners and then designing the former with twice the amount of steel he requires for the latter. This is the point I wanted to bring out, but Mr. Jensen avoided explaining this contradiction in his reply.

Solving for $\frac{wl^2}{24}$ and then doubling the steel, as is done by Mr. Jensen, is equal to using $\frac{wl^2}{12}$ for the materials in tension and $\frac{wl^2}{24}$ for the material in compression. This is a contradiction in itself, it is not specified in any building code to my knowledge.

If Mr. Jensen will tabulate the percentage of steel which he has in his designs he will find that his two-way systems run about twice as high as

the others. This alone shows that something is wrong.

From the amount of steel given in Mr. Jensen's table, it appears that he used $\frac{wl^2}{24}$ in the flat slab case and distributed the steel into the different layers. Mr. Jensen says that $\frac{Wl}{24}$, the moment which I used in the two-way case, is the total moment on a strip the whole width of the panel. According to the Chicago Code, as quoted by Mr. Jensen, the greatest bending moment, $\frac{wl^2}{24}$, is located at the center of the panel. Both are in error, for neither moment occurs. The greatest bending moment in a two-way slab occurs on the diagonals midway between the center and the corners. It is at those points that the first signs of failure show. If a two-way panel is tested to destruction, cracks appear first midway between the center and the corners (Fig. 1). These cracks will then run right across on the diagonals but will not extend into the corners (Fig. 2).

These two sketches show:

First, that the cracks, which show the location of the greatest bending moment, cross all the steel rods; second, that therefore all the steel is

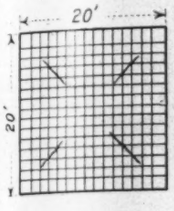

Fig. 1.

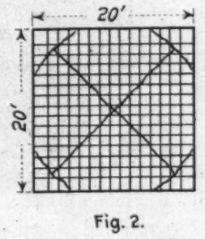

Fig. 2.

always equally in action; third, that therefore it is not necessary to lay the full amount of steel in both directions, and fourth, that the assumption that the two-way slab is nothing but two series of beams at right angles, is erroneous.

I do not know of a single case where a two-way slab tested to destruction has shown the slightest indications of failure in tension or shear, and I do not believe that the formulas used to determine shearing stresses in beams apply to two-way or flat slabs.

I am fully aware of the dangers which may result from shifted bending moments in continuous slab or beam construction, due to unequal or partial settlement of the supports, and I also know that these dangers in two-way construction are not half as great as they are in one-way systems. A two way slab, designed $\frac{Wl}{24}$ — free support, and $\frac{Wl}{36}$ — continuous is a far safer and better construction than a one-way slab designed $\frac{wl^2}{8}$ or $\frac{wl^2}{12}$, first, because of its much greater capacity for concentrated loads, and second, because shrinkage stresses, which are probably responsible for a high percentage of the many failures of long span one-way constructions, are distributed uniformly and rendered harmless in the two-way system.

It is my opinion that if higher bending moments should be used as an additional safety factor against dishonest and incompetent contractors and engineers, they should be used for all constructions, and not only for the two-way slab, as prescribed by Mr. Jensen and various building codes. The two-way slab needs this somewhat peculiar precaution much less than the one-way types.

I am not interested in the two-way tile used in Mr. Jensen's Design No. 6, nor in any of the other tiles handled by the firm which formerly sold said four-piece block, nor did I want to detract in any way from the merit of Mr. Jensen's work. My object was to call attention to the two discrepancies usually to be found in discussions on multiple-way reinforced structures and which happened to show so strikingly in Mr. Jensen's comparative designs; namely, that if a slab supported on its four sides is admittedly at least as strong as a slab supported on its four corners only, a design must necessarily be wrong which requires more materials for the former than for the latter; and second, if a two-way plate breaks on the diagonals its greatest bending moment cannot very well be at the center on lines parallel to the supports.

K. R. Schuster, Assoc. M. Can. Soc. C. E.
113 Bainbridge St., Brooklyn, N. Y., Sept. 13, 1911.

New Orleans Specifications in Relation to Failure to Secure Satisfactory Bids from Contractors.

Sir: In your issue of July 27, 1911, you reprint a report of Mr. Geo. G. Earl, General Superintendent New Orleans Sewerage and Water Board, in which he advocates doing work by force account instead of contract. You comment favorably on Mr. Earl's argument, but it appears to me you have overlooked the most significant fact of Mr. Earl's report. That is, that he does not seem to be getting bids from contractors that are by any means what would be considered reasonable bids. There must be some reason for this and I should think that it would pay for the engineers of the New Orleans Sewerage and Water Board to endeavor to learn why they are unable to receive fair bids on their work, and to so conduct their department that in future contractors will feel justified in bidding with a reasonable margin of profit.

I do not know the reasons for the high bids on the work which Mr. Earl refers to in his report, but recent specifications issued from his office contain clauses which are sufficient to warn the contractor that he must bid high for his own protection. It is because this fault (incorporating) in specification clauses which are inequitable is so common among municipal and government engineers, that I feel justified in commenting on them. These of the New Orleans Sewerage and Water Board are more unreasonable than it is usual to find, but the same fault is entirely too apt to occur in all specifications where the engineer is not vitally interested in getting work done at as low cost as possible.

It is in the general clauses of such specifications that the most objectionable features are found. For instance, note the following:

DECISION OF GENERAL SUPERINTENDENT FINAL.—All work under this contract shall be done to the satisfaction of the General Superintendent who shall in all cases determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for hereunder and shall decide all questions which may arise as to the fulfillment of this contract on the part of the Contractor, and his determination and decision thereon shall be final and conclusive; and such determination and decision, in case any question arises, shall be a condition precedent to the right of the contractor to receive any money thereunder. The General Superintendent shall have the right to correct any clerical, mathematical or minor errors or omissions in the specifications when such corrections are necessary for the proper fulfillment of their intention.

You will note that this clause starts off by specifying that all work shall be done to the satisfaction of the General Superintendent.

The "satisfaction" of an engineer is something over which the contractor may have no control. In other words, it would be possible for a contractor to do work which is absolutely above criticism, and yet he could not compel the engineer to be satisfied.

I once, when signing a municipal contract, called this to the attention of a City Attorney and he stated that the Courts in such a case would decide that the clause meant "reasonably satisfactory"; but a contractor would hardly care to take every decision as to "quality, acceptability and fitness" of work and material to the Supreme Court, in order to have the word "reasonable" read into the specification. No doubt, the engineer who wrote the specifications and the Sewerage and Water Board who approved them, felt that its General Superintendent was a man of sufficiently high standing to be reasonable in all matters of this nature, and that the contractor would have no reason to fear this clause, which requires that his decision be final. You will note, however, that a pretty severe penalty is attached on any question of this decision—in other words, the "right of the contractor to receive any money."

The next paragraph in the specification delegates to "assistant engineers and inspectors the authority of the General Superintendent, limited by the special duties entrusted to each." In other words, the work must be to the satisfaction of every assistant engineer and inspector. It evidently does not occur to the high officials that the "satisfaction" of some of their inspectors and assistant engineers may cost the contractor considerable sums of money. By this I do not refer so much to graft (as I believe that there is less of this on public work than is supposed); but the young technical graduate with no other qualification then a political pull is very apt to read into such specification clauses authority sufficient to consider himself infallible.

Although the paragraph giving the General Superintendent the absolute power to determine quality, acceptability and fitness of the several kinds of work and material, would lead one to believe that the Superintendent considered that it was impossible for himself and his engineers to make mistakes of fact or of judgment; the latter part of the same paragraph does not bear out this belief, as in that it is stated that the General Superintendent shall have the right to correct any "clerical, mathematical or minor errors or omissions." Had this sentence read that they could correct "minor errors," a contractor in making his estimates would be justified in believing that he would not be put to any expense under this clause, except for incidentals which had been overlooked, but the plain English of this clause is not that correction is limited to minor errors; it is evident that they may correct errors and omissions of no matter what magnitude, so long as the corrections are necessary for the proper fulfillment of the "intention" of the specification.

You will note that the decision as to what this "intention" covers, lies with the engineer who wrote the specifications.

There is a paragraph in this specification headed in bold face type **DELAY BY CONTRACTOR** which reads as follows:

Failure to deliver the machinery named in this contract at the time specified shall be authority for the Board to suspend the Contractor and employ other parties to complete the contract, or to wholly annul said contract. If for either of the above causes or for any other herein named, this contract is annulled, all money due to the Contractor at the date of such failure or annulment will be retained until the work is completed and will be applied to the completion of the work under this contract, and the work may be carried on by advertised contract or by private agreement, and its cost shall be held to be properly charged against the Contractor.

You will note this paragraph puts what may be a very severe penalty on the contractor for any delay. In other words, gives the engineer the right to break the contractor. *Delay by the Sewerage and Water Board*—the italics are my own—is covered by a few lines at the bottom of another paragraph, which reads as follows:

PRICES BID INCLUDE.—The Contractor shall accept the amounts stated in his proposal, less any deductions that may be made under the terms of this contract, as full compensation for everything furnished and done by said Contractor under this contract, and also for all loss or damage arising out of the nature of the work, or from the action of the elements, or from any unforeseen obstruction or difficulty encountered in the prosecution of the work, and for all risks of every description connected with the work, and for all expenses incurred by or in consequence of any delay in the completion of foundations or buildings or other delay by the Sewerage and Water Board, and for well and faithfully completing the work and the whole thereof as herein provided.

The charitable supposition of any one reading specifications containing such clauses as these is that the engineer wished the contractors to bid high. In other words, that they wish them to have sufficient profit in the contract to be able to cover up any mistakes made by the engineer, without the necessity of bills for extras.

The municipal contractor with considerable experience is not likely to take quite so charitable a view, and is apt to feel that he is doing a dangerous thing to sign a contract which places his company at the mercy of the engineer to whom he has bid. It would be possible under these clauses for the engineers to ruin him and as long as human nature is such that it is considered good policy to place your most trusted employees under bond, it is a good deal to ask of a business man to put the integrity of his company in the hands of an outsider.

That such clauses are not necessary is shown by the faithful and satisfactory completion by contractors, all over the country, of contracts with business firms where no such clauses are thought necessary. Most contractors take pride in their work and it is not only a matter of business policy but a pleasure to them to have their work done to the satisfaction of their customer. But any lawyer will tell you that to make a *contract* that work is to be to the "satisfaction of the purchaser" is merely to invite delay in payment and to make it very hard to obtain an acceptance if the purchaser is at all unscrupulous.

For an engineer to require that work be "sat-

isfactory" is for him to admit that he can not describe what he desires in the way of quality of material and work. He is justified in doing so only in such cases where it is necessary to match the graining on old and new marble or the color of tile roofing. On work where his opinion as to quality may materially affect the cost of the work, the specifications should be explicit and may then be as exacting as is desired.

It is generally recognized that when articles are sold on trial or "guaranteed to be satisfactory," the price is mostly profit. It would seem a pity to put engineering work in the class with patent bath cabinets.

H. L. Hutson, M. Am. Soc. M. E.

New Orleans, La., Aug. 12, 1911.

[Proof of the foregoing letter by Mr. Hutson having been sent to Mr. Earl the latter has replied as follows:—Ed.]

Sir: In response to [the foregoing] communication addressed to your journal by Mr. H. L. Hutson, I would say:

(1) My report to the executive committee of the Sewerage and Water Board, as published in your issue of July 27, 1911, did not advance the claim that the Board does not get reasonable bids. On the contrary, assuming reasonable bids, the report undertakes to show why the Board can save at least 10% over same by doing certain of its work by its own forces.

(2) It is of record that the Board has awarded something like fifty contracts, varying in value from $100,000 to $2,000,000 each, and only twice have any or all bids been rejected because they were too high. On the first occasion, in 1903, a re-letting effected a reduction of bids about equal in the amount by which the first bids were reported as too high. On the second occasion, in September, 1907, the bids were reported as about 30% too high, and the Board by doing the work itself saved 43%, as compared with said bids.

(3) The paragraphs which Mr. Hutson criticizes are paragraphs taken from the machinery contracts, being substantially the same as existed in the general contracts for water-works pumping machinery upon which the Allis-Chalmers Co., the William Tod Co., the Holly Manufacturing Co., and the Providence Engineering Works' bid. The Allis-Chalmers Co. were the low bidders, were awarded the contract, have completed it, and have been finally settled with. The transaction has been satisfactory to all parties, so far as I know. This was substantially a $500,000 contract, and the bids named were as follows:

Allis-Chalmers Co.	$479,980
William Tod Co.	482,000
Holly Manufacturing Co.	496,605
Providence Engineering Works.	542,000

This is rather close bidding, and by every method of comparison which we can make we feel that the prices bid on this contract were very low, and we know that the work secured was entirely satisfactory.

I have instanced these bids because Mr. Hutson, who writes the foregoing communication, is given in the New Orleans city directory as Mechanical Engineer for H. R. Worthington, which is, as I understand, a subsidiary company of the International Pump Co., as is also the Holly Manufacturing Co., who bid, and so far as I can judge, bid low under these specifications.

(4) It is a fact that the Sewerage and Water Board usually gets plenty of reasonable bids from desirable bidders for all of the work which it advertises for competition, and it is therefore unnecessary to seek causes for unreasonable bids, which are mainly conspicuous by their absence or by comparison with reasonable ones at the same letting.

(5) The general issue raised by Mr. Hutson I will not undertake to discuss. The specifications of the Sewerage and Water Board are drawn by its engineering department and reviewed by its attorney. In matters where it is practicable so to do they are also frequently submitted to known prospective bidders for any fair suggestion which they may care to offer, and they are not recommended for adoption until there is a reasonable certainty that a sufficient competition from reliable bidders under satisfactory conditions will be secured. We have not found thus far that desirable bidders who have had dealings with the Sewerage and Water Board refrain from bidding, or bid higher, because of the clauses referred to.

Yours truly, Geo. G. Earl,

Gen. Supt. Sewerage and Water Board.

New Orleans, La., Sept. 8, 1911.

A Report on the Protection of the City of Scranton From Surface Caving Over Mine Excavations.

Under the entire area of the city of Scranton, Pa., lie thick seams of anthracite coal. It is as the commercial center of the anthracite producing region that the city has grown to its present size and importance. The mining of anthracite on a considerable scale has been in progress over seventy years and vast quantities of coal have been taken from beds located directly under the city. Settlements of the surface over old mine workings have frequently occurred all through the anthracite region; but in recent years the settlements in the city of Scranton itself have become particularly alarming. The great increase in value of city lands and the improvements thereon of course makes the situation more serious.

A further element in the situation is the great increase in value of the unmined anthracite, the rapidly approaching exhaustion of the deposits and the necessity from the public point of view of so carrying on the mining operations as to secure the largest possible proportion of the coal.

Mining operations at the present time are carried on with much more regard to the stability of the workings than was the case in earlier years. However, as a large proportion of the worked out seams beneath Scranton are of early date, protection of the city against further subsidences has to deal mainly with the conditions existing in the old workings.

Some particularly serious subsidences which occurred in 1909, especially the partial wrecking of a public school (No. 16) on Aug. 29, 1909, led to definite action by the city authorities. Committees of the City Councils, of the (School) Board of Control, and of the local Board of Trade urged an investigation. The Mayor, Mr. J. B. Dimmick, consulted the well-known mining engineer Mr. John Hays Hammond, and the latter became so much interested that he joined with others to form an Advisory Board, acting without compensation. This board consisted of: Messrs. John Hays Hammond, D. W. Brunton, Pres. Am. Inst. M. E., R. A. F. Penrose Jr., Lewis B. Stillwell, and W. A. Lathrop.

A specific study of local conditions being necessary to form a basis for conclusions and recommendations, the Advisory Board recommended that Messrs. William Griffith (Scran... and E. T. Conner (Philadelphia, Pa.) be engag... to make this study, which was done. Thes... ntlemen completed a report early in 1911. Th... ort was then considered by the Advisory Boar... he suggestions of that Board incorporated, a... he final report of the Mine Cave Commission ... ented to the city authorities.

Extent and Character of Coal M...ning Under Scranton.

The engineers estimate that the mi... g underneath Scranton, which has been carri... on for at least 70 years, amounts to the follow... figures:

Total coal and refuse extracted	221,000... tons
Marketable coal produced, 27 collieries	177,000... tons
Volume of excavation	198,000... cu. yds.

The last figure is approximately equal to the total Panama Canal excavation.

Concerning the volume of space which now remains open, they say:

It is impossible to say what percentage of the space excavated remains open, but we would express the belief that it does not exceed one-half of the original, due to the numerous squeezes and cave-ins that have occurred and closed the openings.

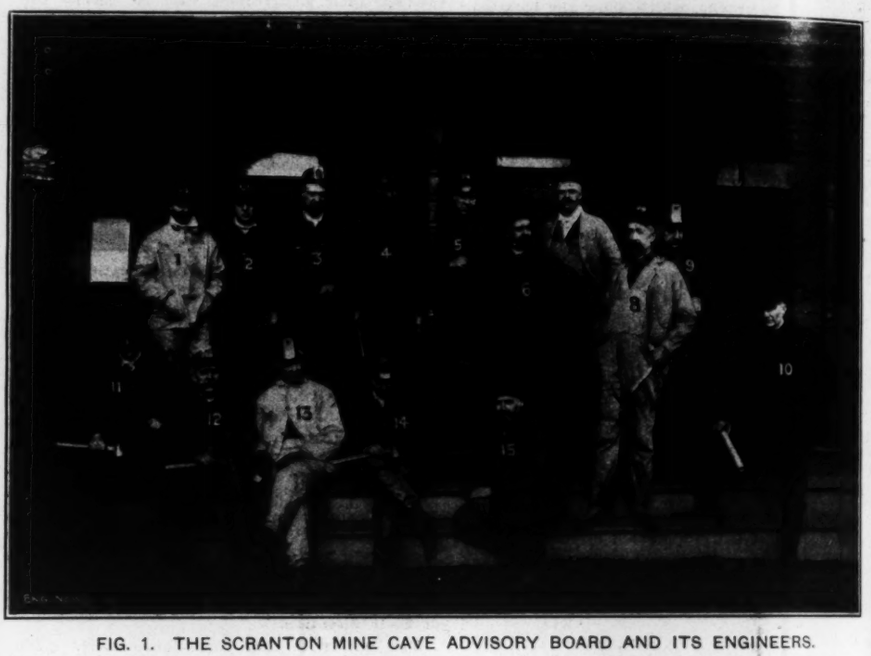

FIG. 1. THE SCRANTON MINE CAVE ADVISORY BOARD AND ITS ENGINEERS.

(Photographed at Oxford Mines.) Copyright 1911. Horgan of Scranton.

1. R. M. McKay.
2. L. D. Conkling.
3. H. M. Smith.
4. J. A. Holmes.
5. A. M. McClellan.
6. Wm. Griffith.
7. Geo. S. Rice.
8. Eli T. Conner.
9. Chas. Enzian.
10. J. G. Hayes.
11. L. B. Stillwell.
12. H. S. Drinker.
13. D. W. Brunton.
14. John Hays Hammond.
15. J. F. Kemp.

The Lackawanna coal basin is about 5 miles wide at Scranton, and the city covers the whole width, the margins of the field on East and West Mountains nearly coinciding with the city lines. The city extends about 5 mi. along the valley. Its whole area is thus underlain by coal. In 1841 the Lackawanna Iron & Coal Co. first used the local coal for iron smelting. Ten years later the first railway was opened, and from that time forward the industry grew rapidly. Representative figures of yearly production for the later period are:

COAL MINED UNDER CITY OF SCRANTON.

	Tons.
1875	2,312,580
1880	2,477,285
1885	3,261,483
1890	4,032,073
1895	4,042,677
1900	4,381,573
1905	6,257,380
1910	abt. 6,000,000

The floor of the basin is hard Pottsville conglomerate, which reaches the surface at Roaring Brook and on the flanks of West Mountain, passing under the central part of the city at a depth of several hundred feet. As the basin is wide and shallow, the strata are generally rather flat in slope, so that artificial pillars are not like-

ly to slip [illegible]hift on account of the pitch of the seams. Al[illegible] West Mountain steep pitches are found, up [illegible]50°, but this condition affects only a small are[illegible] of territory of importance.

FORMER METHODS.—The earlier mining methods ar[illegible] referred to in the following passage:

The roo[illegible]and-pillar system of mining was adopted in [illegible] old mines, and has been continued in all the [illegible]ning of the region up to the present

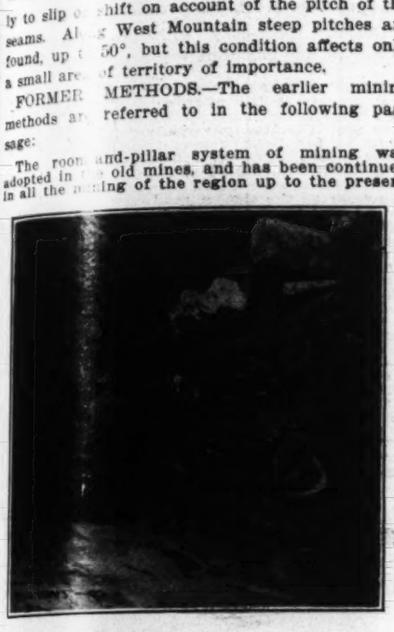

Fig 2. Typical Mine Cogs.

(Rock-filled cribs; the most common device for temporary artificial support of mine roof.)

time. This method consists in driving an airway and gangway about 15 ft. apart, parallel, horizontally in the coal bed. On the high side, chambers or rooms are driven parallel and at right angles with the gangways, about 30 ft. wide, separated by wide partitions called pillars, about 15 ft. in thickness. The coal production of the mine is mainly taken from the contents of the rooms; the pillars, comprising approximately one-third of the coal, being left to support the surface. This practice of leaving one-third of the coal for surface support was adopted at the start, and found sufficient for the comparatively light overburden to be sustained in the mining of the surface veins. It has been continued as an empirical rule, without much variation, in the deeper mining under the city, without reference to the weight on the pillars or the strength of the coal.

In the past the several beds of each mine have been worked independently of each other, no attempt being made to regulate the position and distribution of pillars aside from the one-third rule. Consequently the pillars are not columnized, in other words are not exactly over each other. Many of the thick beds of the middle measures under the Hyde Park and Providence section are quite close together. The pillars, therefore, in these thick beds, not being columnized, have an unpleasant tendency to crush through the interval between the beds, the pillars of an upper bed crushing into the excavation or rooms of the lower workings.

The universal practice in the old days was to mine only the best, thickest and most accessible coal beds, and also to mine only the profitable part of each bed, thus leaving unmined, as refuse, the parts which for one cause or another were found more expensive to work. Some of the coal beds already mined over and ready to be abandoned have been found to carry rider coal above or bottom coal below, which it is profitable now to remove. And therefore for the past few years the total production from several seams has been from the remaining top and bottom coal. This of course leaves the pillars 2 to 6 ft. taller for the same horizontal area than they were before, and consequently much weaker and less able to support the overburden.

In consequence of the several above-related conditions there have been from time to time numerous and more or less serious cavings or subsidences of the surface, principally on the West Side, which have caused more or less damage to surface property, but no loss of life. In every instance the damage has been speedily repaired and temporarily forgotten. The accumulated result of these repeated settlements has probably left certain parts of the surface in that section of the city in more stable condition than before they occurred.

PRESENT METHODS.—The methods employed at the present time for the support of the surface are, (1) the natural method of leaving coal pillars, usually proportioned by the old one-third rule, and (2) placing artificial supports. These latter are described thus:

FLUSHING.—There are several sorts of artificial methods of roof support, the principal and most effective of which is known as the flushing method, by which is meant washing into the mines by means of a stream of water through pipes, coal culm and other fine refuse; thus filling up the desired portions of the mine.

This method was first used in Shenandoah, Pa., by the Philadelphia & Reading Coal & Iron Co. Afterwards it was introduced at Plymouth, Pa., and now has been generally adopted and is in practice over the whole anthracite region,—using culm only, and mainly for the purpose of protecting those portions of the mine or surface which it is necessary to support in order to preserve the mining operation.

Under this city considerable flushing has been done at various places. Foreign engineers, after inspecting the process in this country, have adopted it in Europe, where, much extended and amplified, it is now an essential part of their more recent mining methods by which they are able to recover all the coal, filling the excavated spaces by the flushing method with crushed rock, sand, gravel and soil, using also ashes and city refuse, some of which is transported for long distances over the surface, to the flush pipes. They find that when they thus remove all the coal, a gradual, though small surface settlement results, the amount of which depends upon the depth and thickness of the coal. In this country, however, we cannot hope to profitably use such expensive mining methods as may obtain abroad, because the cost of labor in the United States is very much more and the market price of the coal is very much less than in Europe.

COGS.—It is frequently necessary in the course of mining to make use of some roof-supporting device which may be quickly constructed and is withal possessed of great strength. The timber crib filled with mine rock—known in mining parlance as a cog—has been found to answer these conditions in a very satisfactory manner, and is extensively used in all coal-mining districts. The cog consists simply of a rough crib, of stout logs placed one above the other, log-house fashion, the space between the logs being chinked up with rock from the mine, and the interior filled with mine rock. This construction is very quickly erected, and possesses great strength. Of course, it is not permanent, because the timbers in a few years decay. Cogs are mainly used for the purpose of stopping a settlement, squeeze or creep in the mines which the foreman knows to be imminent or in progress. When sufficient cogs are placed in proper localities, very frequently the roof will crack over the vein, through to the surface, and the progress of the squeeze or creep will thus be stopped.

GOB PIERS.—Gob piers are pillars built of the refuse rock such as may be readily found in most mines, which consists mainly of bony coal, fireclay and slate—mostly soft rocks which do not possess very great compressive strength. These piers sometimes consist of an outer or enclosing wall, square in shape, the interior filled with the mine refuse shoveled into them. In other cases the interior is laid up by hand and the rocks more carefully compacted by filling the voids with fine mine refuse.

A great many such piers have been built under localities in Scranton, for the purpose of supporting the roof under valuable surface improvements. The value, or supporting strength of such piers depends upon the compressive strength of the materials from which they are constructed. This will be greater if the voids between the larger pieces are filled with the small rock and shoveled material from the mine.

Fig. 3. A Chipping Coal-Pillar.

(Note chunks of coal that have chipped off and fallen to the floor. Chipping of coal-pillars is sometimes the first sign that a squeeze is imminent.)

GOB STORAGE IN ROOMS.—Most coal beds consist of interstratified layers of coal, fireclay, slate and bony coal. The three latter, of course, compose the principal refuse material of the mine. In all the mining methods adopted under Scranton all the material of the veins which is not coal is laid aside as refuse and stowed away in the chambers, either on one side or on both sides of the mine tracks; also in thin beds where it is necessary to remove some of the roof rock or take up some of the floor of the mine in order to secure height sufficient for the mules and the men to travel along the roads. Much mine refuse is thus produced, which is also stowed in the chambers. In veins less than 4 ft. in thickness the chambers are frequently filled with mine refuse, or gob, as it is more familiarly termed, from floor to roof. Occasionally this gob is merely thrown in in a careless fashion or shoveled in. In other localities it is packed as tightly as possible by hand. Frequently the whole chamber from pillar to pillar is packed full of mine refuse. Where there is much interstratified fireclay or bone in the coal seam there will be larger quantities of the gob, and the thinner the bed the greater will be the quantity of mine rock raised or taken down for roads. Consequently, this stowage of gob in the rooms of the mines under Scranton becomes an important item when considering the support of the surface over these coal seams. As in the case of the gob piers and the cogs, the supporting value of this stowage gob depends upon the compressibility of the material of which it is composed.

CONCRETE AND MASONRY PIERS.—The above methods of artificial support are comparatively cheaply installed, but there are some other methods used in Scranton, namely concrete and sandstone piers, in which the material for the construction has been introduced from the surface through bore holes in the case of concrete or shafts from the surface in the case of blocks or sandstone, and in the mine wrought into substantial piers by the use of cement. While these forms of pier are much more substantial than those previously mentioned, they are also much more costly; consequently there have been fewer of them installed.

IRON PROPS.—In one case, namely, in the Big Vein, under the High School building in this city, a number of iron props or posts have been installed as additional roof support. There has been no subsidence of pillars in the locality where they have been used, and there the supporting value of these props has not been tested, and thus their efficiency is largely a matter of opinion. In any case they are costly to install, and it is entirely probable that much more efficient means might be used for the same purpose at less expenditure.

Present Condition of Workings.

The coal beds under Scranton form three groups: Surface beds, middle beds, and lower beds. Detailed inspection was made of all mines, and the results are stated separately for the three groups. Various points where settlement threatens or where trouble may be expected at some time are specified in the report, with recommendation for action.

SURFACE BEDS.—Referring generally to the surface beds, those on the west side of the Lackawanna River were found in fairly good condition, the pillar areas generally amounting to about one-third the total area.

When the time comes, however, for reclamation of pillars from the greater part of the area, serious surface disturbances may be expected unless in the meantime some method of support is introduced.

On the other side of the river the same conditions prevail in some of the workings, but others exhibited points of more or less direct danger. Roof falls and cavings have rendered certain parts of some old workings inaccessible, and it is recommended that, to obtain fuller information on the conditions in these parts, openings be made through the falls, or small shafts sunk at various points, to permit accurate surveys and also to serve as avenues for introducing fill material. In the old workings of the Fair Lawn Coal Co. much less than one-third pillar area was left, and unfavorable conditions result:

There is a bench of coal about the center of the bed which is of a considerably softer nature than is the balance, which bench is affected by what is known as "air slack," causing it to chip and flake off, and show the first signs of any undue pressure on the pillars. A very large proportion of the pillars inspected in this bed shows unmistakable signs of pressure. These indicate, we believe, the first stage of "creep" or "squeeze," that if fully started may result in the complete collapse of the pillars in a large part of the area mentioned, which would bring down the roof and unquestionably extend to the surface. Should a general squeeze take place in the Clark bed workings it would certainly affect the pillars and overlying strata of the Big Vein, and result in very serious disturbance of the surface. We deem it important to lay particular stress on the necessity for prompt remedial measures to prevent the **starting** of a general squeeze or creep in the Clark bed at the Pine Brook colliery, with the resulting breakages of gas and water and sewer mains and damages which might follow.

A point of particular weakness in this bed is near the intersection of Adams Ave. and Gibson St., and under the Technical High School. We have been informed that the Scranton Coal Co. has commenced flushing culm into the workings under this important building, and that it is their intention to fill these workings as rapidly as possible. When this flushing is completed and a block of one or two acres is completely flushed,

Fig. 4. A Squeeze, Not Long After Its Start.

it will strengthen not only the point immediately filled but have a tendency to support the roof for some distance on all sides of the artificial pillar thus introduced.

Other points of danger in the shallower workings are also noted in the report, including some signs of squeeze and some points of more remote warning.

MIDDLE BEDS.—In the middle beds the strata between the coal seams are thin, and pillars in the successive levels have not been set over each other:

On account of the failure in the past to columnize pillars, the workings in these beds, **where now open**, constitute a serious menace to the surface, and this portion of the city will be the most expensive and difficult to protect. However, it should be noted that very large areas of the three uppermost beds [of the middle series] have been closed by crushing of the pillars and strata in the past. Where such complete crushing of the pillars and consequent subsidence of the overlying strata and surface has taken place in the past, no serious apprehensions need be entertained of future damage to the surface improvements, unless in the process of mining lower veins insufficient pillar support is left to carry the overburden, and a squeeze or creep takes place, as has been the case recently at the Leggett's Creek mine, where in mining the lower Dunmore bed, 700 ft. deep, the usual (though in

Fig. 5. Flushing Culm Into a Mine.

this case insufficient) rule of about one-third of the coal left in for support was applied.

Where the workings in these beds are not closed by a general crush, and no one knows how large or extensive such openings may be, there is at all times a liability to a repetition of the same kind of subsidence as that which wrecked No. 16 school.

Conditions under two other school buildings are criticized; it is recommended that no further mining be done here and existing openings be filled.

DEEP BEDS.—The lowest series of beds, the Dunmore beds, are thin and have a great depth of overlying cover. The large proportion of refuse serves as partial filling and will be a check to settlement.

The greatest menace to the surface property from these deep, thin beds is through a large general subsidence, a creep or squeeze extending over large areas; and even then the settlement will be gradual, and usually so uniform as to cause little or no damage to surface property except in cases where the uniformity of the subsidence is interrupted or prevented by the presence of very large pillars or solid blocks of unmined coal. In this latter case, buildings near the margin of such large pillars are liable to considerable damage by the side-pull, or unequal settlement.

Strength of Roof Supports.

Scranton anthracite coal was tested for crushing strength in a large series of tests (over 400 test pieces) from 1900 to 1903, under the auspices of the Scranton Engineers' Club. A total number of 122 samples 2 ins. square by 1 in. high showed first crack at 2,980 lbs. per sq. in., and ultimate failure at 6,014 lbs. per sq. in. Similar pieces, also 2 ins. square, but respectively 2 ins. and 4 ins. high, showed first crack strength down to 1,850 and ultimate down to 2,800 lbs. per sq. in.; but for mine pillars the large and short proportion is taken as applicable. These figures would amount to about 200 tons per sq. ft., load at first crack; and over 400 tons per sq. ft. at failure.* The present report, after quoting these figures, says:

*The samples were selected and prepared by the coal-mine operators, not by the committee. The bearing of this fact on the quality of the samples must be allowed for.—Ed.

This average statement, however, does not apply equally to all coal veins, for the tests prove a great variation in strength, even between parts of the same bed, the weight required to crack pillars in some instances being as low as 30 tons per sq. ft.

Presumably the latter figure refers to observations on actual pillars in the mines, where cracking was noticed.

Tests of the load-supporting power of other materials were made for the Scranton Mine Cave Commission at Lehigh University by Prof. F. P. McKibben in January, 1911. These tests may be summarized as follows:

1. Pier of slate, bony coal and fire-clay mine-rock laid up dry, 60 ins. × 28 ins., 18 ins. high. Outer walls laid carefully, filling packed in by hand. Load applied by three I-beams on top. Max. load 489,000 lbs. = 42,000 lbs. per sq. ft. Compression 5.3 ins. Many stones crushed.

2. Timber crib with stone filling, 64 ins. × 32 ins., 23½ ins. high. Max. load 900,000 lbs. Compression 7.1 ins. Many stones crushed.

3. Circular pier of slate mine-rock laid up dry; 28 ins. diameter by 14½ ins. high. Max. load 361,000 lbs. Compression 4½ ins. Many stones crushed.

4. Pile of broken sandstone (1¾-in.); 25 ins. wide (confined by timbers on sides), 34 ins. long on top and 53 ins. long on bottom, 9½ ins. high. Bearing plate on top 20 ins. square; filling of smaller broken stone under plate. Max. load 581,000 lbs. Compression 4.36 ins. Many stones crushed.

5. Pile of broken sandstone, sizes up to a man's head; smaller stones under bearing plate. Pile 25 ins. wide (confined by timbers on sides), 44 ins. long on top and 60 ins. long on bottom, 11½ ins. high. Bearing plate on top 20 ins. square. Max. load 417,000 lbs. Compression 4.6 ins.

6. Pile of river sand, 25 ins. wide (confined), 30 ins. long on top, 50 ins. long on bottom, 8 ins. high. Bearing plate on top 20 ins. square. Max. load 600,000 lbs. Compression 5 ins.

7. Pile of broken sandstone (1¾-in.) mixed with river sand, 2½:1. Pile 25 ins. wide (confined), 29 ins. long on top and 54 ins. long on bottom, 10½ ins. high. Bearing plate on top 20 ins. square. Max. load 800,000 lbs. Compression 4.7 ins.

8. Cast-iron cylinder 6 7/16 ins. diameter by 10 7/16 ins. high filled with coal culm flushed in with water. Load applied by a piston bearing on the culm only. Max. load 200,000 lbs. = 6,150 lbs. per sq. in. or 443 tons per sq. ft. Compression 2.7 ins.

9. Same cylinder filled with broken dry sandstone (1¾-in). Max. load 300,000 lbs. Compression 3½ ins. After the test the stone had to be cut from the cylinder with a chisel.

10. Same cylinder filled with mixture of 1¾-in. stone and river sand. Max. load 300,000 lbs. Compression 2.4 ins. The stone was completely crushed and compacted in the iron cylinder.

11. Same cylinder filled with boiler cinders (anthracite). Max. load 300,000 lbs. Compression 5.3 ins.

12. Same cylinder filled with culm as in Test 8, but dried a week before testing. Max. load 300,000 lbs. Compression 3 ins.

13. Same cylinder filled with dry river sand. Max. load 300,000 lbs. Compression 3.4 ins.

14. Same cylinder filled with sand flushed in. Max. load 300,000 lbs. Compression 1.93 ins.

15. Pile of sandstone in pieces 3 to 6 ins. square. Pile 20¼ ins. wide (confined), 39 ins. long on top (bottom length not stated, but material not confined), 9 ins. deep. Small broken sandstone filled in at top for bearing (size of bearing not stated). Max. load 600,000 lbs. Compression 2.43 ins.

The maximum loads applied do not appear to have been the greatest loads that the respective materials could have borne.

The tests were intended to serve as indications of the strength of cogs, gob piers, culm or sand filling packed or flushed to place, etc. The engineers deduced from them the following table, applying a factor of safety of 2 to the test results:

Supporting Methods Available

Dealing specifically with the Scranton, the engineers say:

While your engineers recognize ing process is the most substanti the artificial support of the roof and that it is also universally suit thin as for thick veins, neverth always applicable or convenient

GOB STOWAGE.—Formerly the mines has been disposed indiscrimi chamber at the side of roadways purpose of getting rid of it at as lit sible; but well-constructed gob pi stronger than those indifferently b evident that in supporting the roof the effort should be to prevent the tlements, and the way in which fo far as possible in the matter of st to carefully pack the particles tig to roof against the sides of the spective of the horizontal area oc the fine refuse, so far as may be, t If the gob now contained in thinn the city of Scranton had been caref as to completely fill the space fro it would not only reinforce and strength of the coal pillars, but it very much greater resistance to from the viewpoint of roof supp much more efficient than under the conditions with from one to two feet

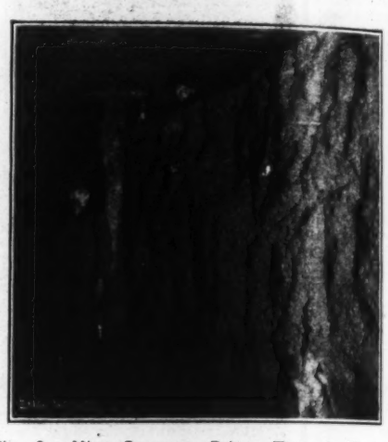

Fig. 6. Mine Gangway Driven Through Flushed Culm After Drying (Walls Stand Vertical).

tween the top of the stowed gob and the mine roof.

In some beds now working there is a surplus of mine rock which cannot be stowed in the chambers and must be hauled out into other parts of the mine. If it is determined to continue thus to stow this material instead of hauling it to the surface and grinding it for flushing purposes, as has been referred to above, it would be better for the purpose of roof support that the places for depositing this surplus stowage should be selected with reference to the weak parts of the mines, or with reference to the support of the surface under some particularly valuable surface improvement.

Very commendable work is being done along this line at the Cayuga mine of the Delaware, Lackawanna & Western Railroad Co., where the pillars are being extracted in a surface vein and the space formerly occupied both by the chambers and the pillars completely filled with surplus rock taken from a lower vein.

BLASTING ROOF AND FLOOR IN THINNER VEINS.—It is a well known fact that loose rock occupies from one and two-thirds to two times the volume of the same weight of solid rock. In other words, if a cubic yard of solid rock be broken to pieces it will occupy a space of one and two-thirds to two cubic yards.

Blowing up the floor of the mine to a depth equal to the thickness of the vein, and blowing down the roof of the mine directly over, to a height equal to the thickness of the vein, would produce a total thickness of loose rock equal to three times the thickness of the coal bed. It would be well packed together and have great supporting power, and withal be a comparatively inexpensive process.

This method might be adopted throughout the Dunmore and other thin veins, by blasing down the roof and raising the floor in the abandoned rooms or the roadways between the gob piles in the chambers. Wherever it is applied the effort should be to completely fill the whole width of the chamber or roadway from wall to wall, so that the resulting loose rock shall be confined between the pillars, thus greatly increasing its resistance to compression. The value and supporting power of this method of roof support and the other following methods will be referred to below.

TABLE OF SIZES OF FLUSHED CULM AND SAND MINE-FILLING TO CARRY ONE-THIRD OF A CITY CLOCK OF 5 ACRES.

(Horizontal sizes in square yards, for various depths and various amounts of permissible settlement. Total area of 5 acres = 24,200 sq. yds.)

Permissible settlement.	Depth 25 ft.		50 ft.		100 ft.		200 ft.		400 ft.		800 ft.	
	Culm.	Sand.	Culm.	Sand.	Culm.	Sand.	Culm.	Sand.	Culm.	Sand.	Culm.	Sand.
3%....	3,424	800	6,848	1,600	13,696	3,200	(Filled)	6,400	(Filled)	12,800	(Filled)	(Filled)
5%....	2,122	452	4,244	904	8,488	1,808	16,976	3,616	(Filled)	7,232	(Filled)	14,464
10%....	848	176	1,696	352	3,392	704	6,784	1,408	13,568	2,816	(Filled)	5,632

CONCRETE PIERS.—During the progress of this investigation many persons have called the attention of our engineers to concrete piers as suitable for mine roof supports. This material is so costly, however, that we have hesitated to recommend it except perhaps in isolated cases where very valuable surface property requires unyielding support and to secure such the expense is no object.

DRY FILLING WITH BROKEN STONE OR SAND.—For the construction of isolated and more substantial low-cost piers in the surface veins under the city to take the place of the gob piers for the purpose of the local support of valuable surface improvements where general flushing is not convenient, we would strongly recommend filling through bore holes from the surface with broken stone or sand, or a combination of these materials.

FLUSHING.—Flushing culm into the mines is being done at nearly all of the collieries within the city limits, and the method, and effectiveness of this kind of support was observed by personal inspection underground.

It is manifest that the quantity of culm available for flushing the extensive mine openings is insufficient, even if all that is now on the surface within the city limits, together with that produced in preparation of the going output, were put into the mines. According to figures we have assembled, and supplemented with estimates, it appears that there has been extracted from the beds underlying the city, approximately 221,000,000 tons of coal and other material. The workings under the city are, of course, not all open, large areas having been closed by general caves and squeezes. It is not possible to determine the proportion of openings that have been thus closed or filled, but a conservative estimate of the space now open would probably not exceed 50% of the original.

The positive protection of all of the surface would appear to require the filling, with some supporting material, of all of the open spaces as rapidly as the coal is extracted; but **such a scheme is, of course, impracticable.** It therefore remains to determine about what proportion of the openings to be flushed would afford reasonable protection. To determine this point definitely would necessitate a much more thorough investigation and more detailed surveys than was contemplated in the general investigation upon which your Engineers are now engaged. We would, however, express the opinion that conditions could be materially improved by the insertion of artificial pillars reinforcing the natural pillars of coal, in blocks of from one to five areas, at points where the danger of subsidence appears greatest; such artificial pillars to be arranged with some degree of regularity, so that the overlying strata between the artificial pillar supports would act as natural bridges. This suggestion is made in order to distribute the relief measures over as large a measure as possible, and keep the burden of expense within reasonable bounds.

The best and most practicable of supports is obtained by flushing refuse material into the openings.

The materials obtainable at Scranton for flushing use are listed in the report as: Culm from old and fresh mine-banks; surplus mine rock from thin beds, and all waste mine banks, ash, slag, etc.; sand and other detritus carried by the Lackawanna River; city ashes, street refuse, cellar material, etc.; and sand, etc., brought in by the coal railways in returning empty coal-cars.

As a program for prosecuting the filling work so as to get the earliest beneficial result for the city, the engineers recommend:

Owing to the great importance of substantial support for school properties, we would suggest that under all schools, and at least 50 ft. outside the lot limits, or rather a distance equal to one-half the depth of bed below the surface, in all beds mined, the openings be flushed full of the best available material. The school properties, being located in all parts of the city and over widely varying mining conditions, would afford good starting-points from which to space the additional artificial pillars necessary for the protection of the surface elsewhere.

Following out the above scheme in systematic order, we would recommend the installation of artificial pillars of flushed sand or culm at each street intersection, where the blocks are of the usual size of about 5 acres. In case of all coal beds of greater depth than 150 ft., such pillars might be sufficiently close if at the block corners, but for less depth the strata might be too weak to bridge across the whole width of a city block even though the usual coal pillars are left in place. Therefore it would be better, in the latter case, to install pillars in the center of each block also, in which case pillars would each be about one-half as large as if located at the block corners only.

In locating artificial pillars intermediate between school properties, advantage should be taken of those localities already flushed by the coal companies. It would be found that considerable filling of this sort has been done.

Early attention to Schools, 12, 23 and 29 is especially important. In locating the supporting pillars advantage should be taken of the large areas that are caved and closed in the Clark, New County, Big, Rock, and Diamond beds, and other portions that are already flushed. The best results will also be obtained, of course, by flushing the lowest beds first and proceeding upwards, care being taken to locate the new pillar in the upper seam over that already in place in the seam below.

The report approaches the subject of cost somewhat cautiously. Applying a unit-cost of $1 per cu. yd. to the areas of pillars given in the table above, the engineers give the cost per foot of bed thickness for a pillar capable of supporting one-third the load of a 5-acre city block, whose figures are in each case one-third those of the above table. They say also:

The approximate cost per foot of bed thickness for each acre of complete flushing under schools and elsewhere, and to take the place of pillars if removed, would be:

For culm below level of river.....	$405
For sand above or below river.....	$1,615

For the 7-ft. Clark bed, 200 ft. deep under the Central City and Hill sections, filling sufficient to relieve the existing pillars of one-third their load will cost per acre, $1,960 for culm flushing (below river level only) or $1,680 for sand flushing.

It is urged by the engineers that on account of the importance of the coal mining industry to Scranton all planning and execution of mine-filling work be done in harmonious cooperation of the city, the school authorities and the coal companies. It is recommended that a Protective Commission be established of three or five members, representing the three interests mentioned.

Conclusions.

The engineers summarize their work in the following conclusions.

1.—Speaking broadly, the surface of the city can be supported by the methods recommended, and at a cost not in any sense prohibitory when considered with relation to the value of the property and activities for which support is absolutely essential.

2.—While there are points in the city where at the present time in our judgment there is distinct and immediate danger to life and property, yet the total of such area immediately threatened constitutes but about 15% of the entire area of the city, mainly from surface beds.

3.—On the west side the Middle Series of beds are thick, and close together, and the pillars not columnized, creating a dangerous situation where the workings have not been closed by previous caves. Particular areas thus threatened cannot be definitely specified, on account of the inaccessibility of much of the mined-over area. Detailed investigation should be made of the portions of the mines not already closed. Relatively we do not believe that a large part of the territory mentioned is threatened, on account of so much having been previously closed by caves.

Special attention is called to the conditions under Schools Nos. 12, 23 and 29. They should be promptly attended to.

The lower series of beds, namely the three Dunmores, are so thin, and so far below the surface, that with the usual system of mining we do not think they constitute a serious menace to the improvements on the surface, except along the margin of solid blocks of unmined coal and near the outcrops. In the deep-lying Dunmore beds we believe these solid blocks should be mined.

4.—It would seem, therefore, to be not only the part of wisdom, but absolutely obligatory to at once commence to give support to the points menaced, and thereupon proceed upon a general policy of giving support to the entire area of the city; for it must be borne in mind that with the mining activities that are constantly going on, other and additional points of danger are not only liable to, but in all probability will, occur with each passing year; it might almost be said, with each passing month.

5.—Where the owner of the surface has undoubted right to support thereof by coal pillars, in our opinion he could permit the removal of such pillars, and the value thereof would, under average conditions, pay for such artificial support as we have recommended, assuming that the pillars were mined and the support constructed by the same operating company. This observation, however, is based upon the assumption that in such case the operating company is one of the large transportation companies, inasmuch as while there might not be a profit in the immediate transaction of mining the pillars and installing the support, there would, of course, be a profit to such companies carrying the coal to market.

6.—Culm flushing should be used only in coal beds having light cover, up to 200 to 500 ft., according to amount of settlement expected. But sand, being four or five times as strong as culm, is best, and suitable for all beds under Scranton, and should be preferred.

7.—We believe that the conclusions adduced from the tests made, and the calculations and tabulations based thereon are reasonably reliable, yet we desire to record the opinion that there are conditions existing in the mines where they might not apply, for instance in localities where several seams of coal are separated by thin strata or shale and slate or even sandstone, and the pillars in the two or more seams are not over one another, and it is proposed reclaiming all or any part of the pillars. Even though an application of the above tables might appear to fit the conditions, we believe that the only permissible procedure would be to first fill with flushed material all of the openings in the lowest vein of the series, and thence upwards, until all are filled, care being taken to have the flushed areas over one another. After all of the openings in all of the seams have been filled the coal pillars in the upper bed might then be attacked. No pillar reclamation to be permitted in any of the other beds until all of the pillars in the upper bed have been removed and the overburden has come to rest on the flushed material; after which the pillars in the next lower seam may be attacked and handled in like manner.

Annual Convention, New England Water Works Association.

The thirtieth annual convention of the New England Water Works Association was held at Gloucester, Mass., Sept. 13-15. Although the attendance was unusually small, the papers somewhat limited in number and the discussions on the papers not extensive, the consensus of opinion seemed to be that the convention was nevertheless a success. Ample opportunity was afforded for social intercourse, including private exchange of opinions on technical subjects and the routine work of the operating officials, and this, after all, is generally the most valuable service rendered by conventions.

The usual exhibit of water-works appliances seemed more perfunctory than usual and presented little that was new. This led some of those present to question whether such exhibits are really worth while, except for the presentation of novelties. There was a diversity of opinion on the subject, as might be expected.

The convention opened on Wednesday morning with the usual address of welcome on behalf of the city in which the convention was held, which in this case was delivered by Mr. Isaac Patch, Mayor of Gloucester. Aside from the election of new members, there was little or no business transacted except the selection of a committee to nominate officers to be balloted upon at the annual election next January. The committee, as appointed by Mr. Allen Hazen, President of the Association, was as follows: Edwin C. Brooks, Cambridge, Mass.; J. C. Whitney, Newton, Mass.; Wm. F. Sullivan, Nashua, N. H.; E. E. Lochridge, Springfield, Mass., and W. C. Hawley, Wilkinsburg, Pa. Altogether there were eight papers on the program. To these was added a volunteer paper by Mr. John W. Moran, Superintendent of the water-works at Gloucester, describing the works in his charge.

CALIFORNIA VIEWS AND NEWS.—In addition to the set program, President Hazen showed some very interesting lantern slides of rebuilt San Francisco, the works of the Spring Valley Water Co. of San Francisco and the Hetch Hetchy and Yosemite Valleys. The Hetch Hetchy views were particularly interesting, since they showed the site of the reservoir for the proposed municipal water-supply of San Francisco, which has given rise to so much agitation on the part of the "nature lovers" in various parts of the United States. Mr. Hazen explained that the Hetch Hetchy Valley is very inaccessible, that the official records show that it is visited by only a very small number of people and that it was so infested with mosquitoes at the time of his visit that one could stay there only with great discomfort.

Mr. Hazen explained that the floor of the valley, or the meadows as it is called, is now owned in fee simple by the city of San Francisco, and that the water rights of the Tuolumne River have been acquired by the city from the state exactly as water rights would be acquired by any municipality or private company elsewhere in California. Less than half of the land, however, was secured from the United States Government when Mr. Jas. A. Garfield was Secretary of the Interior. Subsequently, Mr. Richard A. Ballinger, while Secretary of the Interior, took the very extraordinary step of issuing a notice to the city of San Francisco to show cause why these land grants should not be revoked. A commission of army officers has been appointed to report on this subject, and the city of San Francisco has been securing evidence by the aid of Messrs. Hazen, John R. Freeman and others, to support its claims to the Hetch Hetchy Valley as a reservoir site.

Papers and Discussion.

We shall give only a brief resume of the papers presented at the convention, partly because of the general character of a number of them and partly because several have been reserved for separate treatment.

EFFICIENCY.—Two papers were presented dealing with efficiency in water-works organization and management. The first of these was

by Mr. W. H. Richards, Engineer and Superintendent, Water and Sewer Department, New London, Conn. Mr. Richards urged that water boards should be free from politics and that the executive staff of a water-works should be entirely separate from the legislative branches of the city government.

Calling the leading executive officer "superintendent," for convenience in his remarks, Mr. Richards said that this official should be an engineer, though not necessarily one holding a "sheepskin." The superintendent should be the sole responsible executive head of the water department, and as such must be largely autocratic, with full powers of appointing and dismissing assistants. The superintendent should realize that careful planning is essential. This was forcibly expressed by the statement that the superintendent can do better work in his office than in his automobile.

Mr. Richards said that a precise system of accounting would stop many leaks in the water-works system. Unfortunately, few water-works strike a balance sheet. In conclusion, Mr. Richards stated that the secret of efficiency is a combination of system and well-defined rules, fairly and impartially enforced.

Much of the discussion on this paper turned on an eight-hour labor law which has recently become effective in Massachusetts. Under this law no laborer is permitted to work more than 48 hours in a given week. If through overtime a total of 48 hours has been worked by any man before the end of the week, he is not permitted to work any more during that week. The penalty for violating the law is $1,000 fine or six months in prison. Mr. A. E. Martin, Superintendent of Water Works, Springfield, Mass., remarked that some of the Massachusetts superintendents are liable to be hauled up any day and fined a thousand dollars by a disgruntled water consumer. He had made up his mind to give his customers good service at the risk of violating the law, but was of the opinion that very few superintendents could stand more than a single fine and continue to support their family. He stated that a similar law was twice vetoed by ex-Governor Draper, but had been signed this year by Governor Foss. The legislative bill had been modified in accordance with suggestions by the State Supreme Court. (It may interest readers in other states to know that Massachusetts has the unique practice of submitting certain legislative bills to the State Supreme Court for opinion and advice prior to their passage.)

There was considerable speculation by several participants in the discussion as to whether a man would do as much in a nine-hour as in a ten-hour day, and if so whether he would do as much in eight hours as in nine. No definite conclusion was reached, although several speakers expressed a strong belief that a reduction of the length of a ten-hour working-day results in an increase of unit-time efficiency, though no one undertook to say just where this increased efficiency would stop if the working-day were continually shortened.

Mr. A. A. Reimer, Engineer and Superintendent of Water Works, East Orange, N. J., said that the water-works superintendent must be autocratic as to the employment and discharge of men if he is to be held responsible for results. He thought that the rapid spread of the commission plan of city government was an indication of the demand of the day that some one man be held responsible for each municipal department. He stated also that the New Jersey Legislature passed an eight-hour law this year, but that overtime is permitted in case of emergencies [as in Massachusetts] provided proper compensation is given.

Mr. W. C. Hawley said that there was particular need for those in charge of municipal plants to give attention to efficiency. He and several other members commended the water-works decisions of the Wisconsin Railroad Commission for the soundness of their opinions and their suggestions bearing upon various phases of water-works policy.

The second paper on water-works organization and efficiency was by Mr. E. M. Peck, Distribution Engineer, Hartford Water Works, Hartford, Conn. Mr. Peck emphasized the importance of organization and of making the parts of the human machinery work in unison. He deprecated the frequent changes in city administrations, remarking that by this means clerks and foremen come to have more real power than superintendents. Mr. Peck submitted five suggestions looking to efficiency: (1) Get a good superintendent; (2) keep free from politics; (3) join the New England Water Works Association; (4) have an understudy, and (5) visit other water-works. As to the need of an understudy, Mr. Peck stated that a competent assistant always strengthens a competent chief. The author also suggested that when a water-works department is found to be in a run-down condition and to need reorganization it is advisable to consult a man outside the department; and preferably ouside the city. He further suggested the desirability of securing legislation which would tend to fixity of tenure of water-works superintendents.

FEATURES OF THE ADDITIONAL WATER-SUPPLY OF NEW YORK CITY.—Three important papers under this general head were presented. The first was by Mr. A. J. Provost, Jr., New York City, and was entitled "Protection of New York's Water-Supply from Pollution During Construction Work." The paper dealt particularly with the sanitation of construction camps so located as to imperil the sources of supply now drawn upon in the Croton and Bronx drainage areas. All these matters are carefully covered in contract specifications and are supervised with equal care by officials appointed for that purpose. The construction camps have been located with a view to their sanitary relations to existing water-supplies. Sewers and sewage-purification works have been built in a number of instances, and in addition provision has been made for treating surface drainage, including in some instances not only the surface flow from streets and yards, but also the treatment with hypochlorite of the whole flow of streams receiving this drainage. Where sewage systems have been impracticable, closet incinerators are used. Garbage incinerators are also provided. Medical inspection for the detection and control of communicable diseases is one of the notable features of this sanitary work, which is even carried so far as to require vaccination of every laborer.

The Hudson River crossing of the Catskill Aqueduct, by means of a deep-pressure tunnel, was described in detail by Mr. Robert Ridgway, Department Engineer, Board of Water Supply, New York City (see Eng. News June 1, 1911, p. 654, for the latest of several articles regarding the exploratory and also the actual construction work for this tunnel). Work on the west tunnel heading has progressed nearly a third of the length of the tunnel, but owing to delays incident to controlling the water and to the installation of plant, comparatively little progress has yet been made on the east tunnel heading.

The protection of steel pipes in the Catskill Aqueduct was also described in detail by Mr. Alfred D. Flinn, Department Engineer, Board of Water Supply, New York City. The pipes in question are those used for siphons, and, instead of being protected, as might at first be supposed, by asphaltic or other bituminous coatings, they are first thoroughly cleaned of mill scale by acid treatment, and subsequently covered both outside and in with concrete.

All three of the papers on the New York water-supply were illustrated with lantern slides, and will add materially to the value of forthcoming issues of the "Journal of the New England Water Works Association."

FILTERING SALT WATER FOR THE BENEFIT OF THE FISH INDUSTRY.—Mr. Robert Spurr Weston, of Boston, presented an unusually interesting problem and its solution, which was made all the more interesting because of the fact that it had arisen in Gloucester, the place of meeting of the convention. The problem related to the provision of suitable water for use in the fish-curing industry of Gloucester, and had arisen in the first instance by what is technically known as the reddening of the fish during curing. An investigation showed that the salt [illegible]r used in the fish industry was polluted, and [illegible]led to the installation of two slow-sand filtrati[illegible] plants for treating water from the harbor. A[illegible]bstract of Mr. Weston's paper is given elsew[illegible]re in this issue.

WATER - PURIFICATION EX[illegible]RIMENTS CONDUCTED BY BRISBANE, Q[illegible]NSLAND, AUSTRALIA.—A water-supply decl[illegible]l by President Hazen to rank in bad chara[illegible] with the old Ludlow supply of Springfield, Mass., the Goose Creek supply of Charleston, S. C., and some of the supplies in the Panama Canal Zone, has given rise to an interesting seri[illegible] of experiments conducted by the city of Bris[illegible]ne. What was really a paper of considerable [illegible]ngth, with the title "A Short Account of Some Purification Experiments with a Surface Wate[illegible]n Queensland, Australia," was contributed [illegible] Mr. Hardolph Wasteneys, of the Rockefeller Institute of Medical Research, New York City. The water-supply in question is of surface origin and its quality, as described by the author, was spoken of as being "a source of reproach to the city." The difficulty was caused by very heavy growths of fresh-water plants and by the accumulation of organic matter on the bottom of the reservoir. The water in the reservoir "overturns" but once a year, and is stagnant at depths below 19 ft. for eleven months out of the twelve, thus favoring almost continuous putrefactive processes. Therefore it was necessary to find some method of removing tastes and odors, as well as both color and iron. Numerous experiments were made, the most important of which were described in the paper, the latter including coagulation and rapid filtration, ordinary slow continuous sand filtration, slow intermittent sand filtration, the Anderson process (treatment with scrap iron in revolving cylinders) and aeration and filtration of the bottom water from the reservoir. During the investigation, as some of our readers will remember, Mr. Allen Hazen was called to Brisbane (1907) by the water authorities of that city. He advised an intermittent sand filter similar in design to one built to treat the Ludlow water of Springfield, Mass., constructed some years ago under his direction as consulting engineer. The author stated that this filter plant is now nearly complete. We hope to give some account of the Brisbane experiments in a later issue.

THE EFFECT OF THE HOT SPELL OF 1911 ON WATER CONSUMPTION.—This subject was suggested on the program as appropriate for a "topical discussion." Comparatively little information was brought out. Several speakers reported that, while the very hot weather naturally tended to increase the water consumption, either serious water shortage at the time or the use of meters held the consumption in check. Mr. J. C. Whitney remarked that practically all the water-supply of Newton (Mass.) is metered, so that he always has the satisfaction of knowing that increase in consumption means an increase in income. This sentiment seemed to meet with the hearty approval of those present.

An Irrigation Bond Issue of $3,000,000 is to be voted upon by the Union Irrigation District in the lower Rio Grande Valley, Texas, on Sept. 16. The proposed district includes 185,000 acres of land, and if the election results are favorable, as it is expected, it will be the first district to be formed in Texas under recent legislation. We are informed that this Texas irrigation district law is modeled after the Wright Act as passed by the Legislature of California in 1887 and amended since that time. The Texas law restricts the indebtedness of any irrigation district to 25% of the assessed real estate value of the district. The Union Irrigation District project includes a water-supply from the Rio Grande with a concrete head-gate and dam and with more than 40 miles of main canal, besides numerous laterals. The proposed bonds would run for 30 years with an option of payment at the expiration of 21 years, failing which payment would be made in nine equal installments. In any event, annual tax levies will be made to meet interest and principal. Mr. Jas. B. Wells, of Brownsville, Texas, is the legal representative of the promoters of the district.

Slow Sand Water Filtration Plants Treating Salt for the Fish Industry at Gloucester, Mass.

What promises to be a new application of water purification was the subject of an interesting paper presented before the New England Water Works Association, on Sept. 13, by Mr. Robert Spurr Weston, Assoc. M. Am. Soc. C. E., Consulting Engineer, Boston, Mass.

The introduction of slow-sand filters by the big fish-curing and packing establishments of Gloucester came about in a rather peculiar way. It appears that it was the outcome of a bacterial study made by the Bureau of Chemistry, U. S. Department of Agriculture, conducted largely for the purpose of determining the causes of the "reddening" of salt codfish. This and "some other salt-cured fish," to quote from Mr. Weston's paper, "are subject to spoilage when exposed to a temperature above 65° F. This spoilage is manifested by the surface of the fish turning red and emitting a foul odor." The reddening is not new, but has become of increasing importance in recent years with changes in the industry.

Those who wish to go more extensively into this and other interesting phases of the fish industry were referred by Mr. Weston to Bulletin No. 133 of the Bureau of Chemistry, U. S. Department of Agriculture, prepared by Mr. A. W. Bitting, Inspector in the Bureau of Chemistry. Mr. Bitting found that the reddening was due to the existence of Oidium morrhuae, a mold-like fungus, the growth of which is attributed to the use of impure salt water for washing fish. Until recently, this water has been taken by the fish establishments of Gloucester from the harbor and used without purification. The harbor, it appears, is subject to pollution by more or less city sewage, the surface drainage of the city and the industrial wastes from the fish-curing establishments themselves. The Bureau of Chemistry found B. coli on market samples of salt fish.

One of the fish packers at Gloucester installed a mechanical filter to treat the harbor water, but, according to Mr. Weston, owing to poor design of the filter, the effluent contained not only large numbers of bacteria in general, but an abundance of B. coli. Although Mr. Weston's paper does not contain a definite statement on the subject, we infer that the mechanical filter plant was installed before Mr. Weston's services were engaged in behalf of several of the fish packers of Gloucester. One of these packers installed a slow-sand filter, which Mr. Weston describes as being "of the usual type," and subsequently the example of this packer was followed by others.

The foregoing statements are based upon the introductory portion of Mr. Weston's brief paper. The balance of the paper, including all the author gave in the way of description of the purification plants, is as follows:

CUNNINGHAM AND THOMPSON PLANT.—The first of these filters was built for Cunningham & Thompson, of Gloucester. The capacity is 5,000 gals. per hour. The filter consists of a wooden tank containing 3 ft. of sand supported upon a 1-ft., graded gravel layer. The effluent from the filter discharges through a floating orifice regulator into the clear-water basin, from whence it is pumped to the plant by means of a motor-driven pump controlled automatically by a float-switch; another pump, also controlled by a float-operated automatic switch, supplies water to the filter.

When the filter was designed, the writer could find no precedent to guide him. On general principles he believed that bacteria could be removed from salt water more readily than from fresh water because of the well-known tendency of salt water to coagulate certain kinds of colloidal matter discharged into it. A search of the literature was fruitless, and, aside from a few aquariums where salt water was filtered for use in observation tanks, no examples of salt-water filters could be found on record. It is for the recording of the results of the operation of this filter that this paper is written.

The raw sea water taken from the outer harbor, at the Cunningham & Thompson works, is much purer than the water of the inner harbor. It is, however, polluted with sewage discharged at the southwesterly side of the city, at a point less than 1,000 ft. distant from the intake. A partial analysis of the water was made on Nov. 14, 1910, and the results are as follows:

Constituent.	Parts per million.
Nitrogen as free ammonia	0.108
Nitrogen as albuminoid ammonia	0.112
Nitrogen as nitrites	0.007
Bacteria at 20° C.	Liquefied plate.
Bacteria at 37° C.	95 per c.c.
B. coli	Present

The above shows the slight degree of pollution of the water.

The filter was put in operation in May, and since then bacteriological examinations of the influent and effluent have been made and the results are as follows:

Date of Examination, 1911.	Bacteria per c.c. Growth at 20° C. Unfiltered.	Filtered.	Growth at 37° C. Unfiltered.	Filtered.
May 17	1,250	350	340	75
May 24	875	290	192	65
June 6	560	65	75	18
June 20	665	130	340	62
June 29	320	49	130	19
July 19	560	75	290	45
Aug. 7	160	42	134	28

[In seven sets of samples 3, 6, 4, 5, 7, 4 and 2 B. coli per c.c. were found in the successive samples of unfiltered water, but only the first corresponding sample showed coli (.03) in the filtered water.—Ed.]

The above results show the remarkable removal of Coli by the filter, even during the first month of operation, and, furthermore, a reasonable bacterial efficiency. Since June 20 the results, at no time bad, have been very good. It is believed, however, at present writing that, while the removal of B. coli is excellent and satisfactory, the aging of the filter is as necessary for the removal of other bacteria as is the case when fresh water is filtered.

GORTON-PEW PLANT.—A second filter is now under construction for the Gorton-Pew Fisheries Co. The water to be filtered is from the inner harbor, near the landing place of the Boston and Gloucester steamers, and is much more highly polluted than that from the outer harbor. For this reason provision has been made to aerate the water before filtration and to filter at a slower rate than in the previous case.

Two filters, each 21 ft. square, a clear-water basin 32 ft. long by 10 ft. wide by 10 ft. deep, and a pump house 10 ft. square, as well as all the accessory parts, are included in a reinforced-concrete structure, about 47 ft. by 36 ft. in area. Nearly the whole of the structure is above ground, and rests upon a ledge. The regulating chambers are built within the clear-water basin. These, as well as the filters, are covered with a wooden house, while the clear-water basin and pump-house are covered with a concrete-slab roof. The filters are of the usual type and contain 4 ft. of sand supported upon 1 ft. of graded gravel, underdrained with split tiles.

Water from the harbor will be pumped through the aerators into the filters. Filtered water will flow into the regulating chamber inside, from which it will be pumped through a floating regulator, consisting of a float and submerged orifice, which in turn will discharge into the clear-water basin, from whence the water will flow either by gravity to the wharves below or be pumped to an elevated tower tank.

It is estimated that this filter will have a capacity of 100,000 gals. in 24 hours, at a rate of 5,000,000 gals. per acre per diem, or about 80,000 gals. at a 4,000,000-gal. rate.

Under the escort of Mr. Weston, a considerable number of those in attendance at the convention named in the opening paragraph visited the second of the two filter plants described by Mr. Weston. The concrete and wooden structural portions of the purification plant were found to be completed and the coarser material in place ready for spreading the sand.

A Gasoline Tank Explosion on the schooner "Whisper," Sept. 10, 100 miles southeast of Port Limon, Costa Rica, off the Nicaraguan coast, sank the ship and caused the death of her crew of 14 men. Reports state that the vessel caught fire while transporting several large tanks of gasoline and that the explosion occurred after the ship had burned to the water's edge.

A Powder Mill Explosion, Sept. 13, destroyed mill No. 7 of the American Powder Mills plant at South Acton, Mass. Reports state that this was the first explosion at the South Acton plant in nearly a year. This explosion is distinguished by the fact that no one was hurt. There was no one in the mill at the time of the explosion.

A Fire at Rio Janeiro, Brazil, Sept. 17, destroyed the National Printing Works and other property of a total value estimated at $5,000,000.

A Rear Collision between a work train and a freight Sept. 13 on the Lake Erie & Pittsburgh Ry., in the outskirts of Cleveland, Ohio, caused the death of four men and badly injured 14 others. The accident is ascribed to a misunderstanding of signals. The work train was backed from a siding onto the main line directly in the path of the freight, which was moving toward Cleveland at high speed.

Gas in a Well near Kenwood, Pa., Sept. 12, is reported to have caused the death of two men who had been engaged for several days in digging the well. One of the men was asphyxiated while installing the pump in the completed well, which was about 25 ft. deep, and the second was overcome while attempting to rescue his fellow workman. The two bodies were recovered, after several unsuccessful attempts at rescue, by a man who was let down into the well with one end of a garden hose held in his mouth to supply him with fresh air from above.

A Wind Storm at Springfield, Ill., Sept. 13, broke plate-glass windows, brought down trees and telephone poles and unroofed a number of buildings. The copper sheeting on the state-house roof and dome was ripped off and dropped to the ground.

The Steamer "Ramona" sank Sept. 10 off Spanish Island, Alaska, carrying down with her $180,000 in gold bullion from the Treadwell mine, consigned to San Francisco. Reports state that the owners expect to recover the bullion without difficulty.

Runaway Mine Cars at the Marvine colliery, Scranton, Pa., Sept. 12, killed four men and fatally injured a fifth. Four loaded cars were released by the breaking of the cable, according to reports, when near the top of the incline and traveled 1,600 ft. down a 45° slope, before striking the five miners.

The First 110,000-Volt Transmission System in Europe is reported by E. G. Fischinger in the "Electrotechnische Zeitschrift" of Aug. 17. This line extends from the main plant of the Lauchhammer metallurgical works to two other plants and through the district around the towns of Grossenhain, Oschatz and Meissen in Saxony. Bituminous coal is mined near the main plant and the energy is transmitted electrically in preference to shipping the coal to small central stations. The generating station will contain finally four three-phase turbo-generators, each of 5,000-KW. capacity. It is expected that 12,000-KW. will be supplied to the towns mentioned, and for this local supply the voltage will be stepped down to 60,000 and 15,000 volts.

By a Fall of 600 Ft., Louis Rosenbaum, an exhibition aviator, was killed on Sept. 19 at a county fair in Dewitt, Iowa. He was making a flight in a Curtiss biplane with which another aviator had had trouble. A gust of wind is believed to have tilted the machine excessively and disarranged the mechanism so that control was lost. Another county-fair aviator, Frank Paine, was killed at Albion, N. Y., on Sept. 14. His biplane flyer turned over, fell and pinned him down.

The two transcontinental aeroplane trips noted in previous issues, and the one since started have been temporarily suspended. R. G. Fowler is still awaiting repairs to his machine wrecked at Alta, California. J. J. Ward, who left New York on Sept. 13, succeeded in reaching Corning, N. Y., 280 miles, in four days, but burned out his engine there. C. P. Rodgers left New York City (Sheepshead Bay) on Sept. 17 and arrived at Middletown, N. Y., 80 miles way, in 1 hr. 53 min., but wrecked his machine in a tree on continuing his flight next day.

Pine Straw as a Road Surfacing is being used extensively on highways in Florida. Large quantities of the straw have heretofore been burned as rubbish. Reports state that automobilists of St. Augustine are planning to cooperate with the good roads organization of St. Johns County to secure the surfacing with pine straw of portions of the John Anderson highway, between Augustine and Jacksonville.

Boiler, Elevator and Flywheel Accidents in the United States and Canada during the month of July, 1911, according to the list published by the Fidelity & Casualty Co., of New York, caused the deaths of 33 persons. There were 24 boiler explosions during the month, by which eleven persons were killed. Elevator accidents numbered 74 and killed 19 persons, of whom 14 were struck or caught by elevator cars, four fell down shafts and one was struck by another man falling down a shaft. Flywheel explosions, including three grinding wheels and one steam turbine rotor, numbered 13 and caused three deaths, two of which were due to the turbine accident.

The Centering of an Arch Bridge Collapsed in Switzerland on Aug. 29, 1911, and eleven laborers were killed in the fall ("Schweizerische Bauzeitung" of Sept. 2). The bridge is on the section from Bevers to Schuls, of the Rhaetian Railways, crossing the Mela gorge, and is to have a span of about 110 ft., with track grade 110 ft. above valley bottom. The cause of the collapse is not known. This accident is the "bridge collapse" noted in our issue of Sept. 7, on the basis of cable dispatches.

Deferred Cable Messages at Cheap Rates are to constitute a class of service recently announced by the Western Union Telegraph Co. This is virtually an extension of the scheme of "day-letters" and "night-letters" which has been in use in the United States for many months. The Western Union Co. has leased the cables and equipment of the Anglo-American and Direct U. S. Cable Cos., and these are to be coordinated with the cables and equipment of the Western Union Co., giving a group of eight cables between America and the British Isles. There will be, when this arrangement is completed three large groups of cables between America and Europe: (1) the Western Union; (2) the Mackay, connecting with the Postal telegraph system in this country, and (3) the French lines, connecting with both Western Union and Postal lines here. This deferred-message service is undertaken to utilize the idle equipment of the coordinated systems in the Western Union group at off-peak hours. The peak load (with 65% total capacity utilized) occurs at about 11 a. m., New York time, which is 4 p. m., London time. Use of the cable service drops off slowly until about 2 a. m., New York time (7 a. m. London time), when there is only 3% of the maximum capacity in use. The service then rises sharply from this early hour to the peak hour.

A Patent on Flat Slab Reinforced-Concrete construction has been finally issued to Mr. C. A. P. Turner, M. Am. Soc. C. E., of Minneapolis, Minn., nearly seven years after the original application was filed in the United States Patent Office. The patent, numbered 1,003,384, has been delayed by the several interference proceedings which resulted favorably to Mr. Turner. There are a number of suits for infringement of this patent now pending which should soon be determined and the decisions in which should finally settle the scope of Mr. Turner's control over his so-called "Mushroom" system of construction.

Personals.

Mr. R. B. Burke has been appointed Acting Chief Engineer of Construction of the Chesapeake & Ohio Ry., at Richmond, Va., to succeed Henry Pierce, M. Am. Soc. C. E., who died recently.

Mr. W. S. Austin, M. Am. Soc. M. E., has resigned his position as Mechanical Engineer of Westinghouse, Church, Kerr & Co., to take a position with the Eastman Kodak Co., at Rochester, N. Y.

Mr. Peter Schwamb, M. Am. Soc. M. E., has retired from his position as Professor of Machine Design and Director of the Mechanical Laboratories at the Massachusetts Institute of Technology.

Mr. Eugene B. Cushing has been appointed Inspector of Public Works of Los Angeles, Cal., with a salary of $3,600 per year. His duties will include general supervision of all street work and garbage collection.

Mr. Gaetano Lanza, M. Am. Soc. M. E., Professor of Theoretical and Applied Mechanics, in charge of the Department of Engineering of the Massachusetts Institute of Technology, has been made Professor Emeritus.

Mr. Horace W. Clarke has resigned his position as Second Vice-President and General Manager of the Denver & Rio Grande R. R. Reports state that he will retire from railway work and reside on one of his farms in Maryland.

Obituary.

Henry North Peck, a civil engineer, who had specialized in concrete construction, died Sept. 6 at a hotel in Rutland, Mass., aged 28 years.

Charles D. Chanute, the only son of the late Octave Chanute, died in a hospital at Mt. Vernon, Ill., Sept. 17, aged 44 years, from blood poisoning. The death of his father, who was a past-president of the American Society of Civil Engineers, occurred Nov. 23, 1910.

Henry Martin French, a contractor and builder of Springfield, Mass., died Sept. 13 at the home of his daughter in Southampton, Mass., at the age of 84 years. Before removing to Southampton, four years ago, he had resided for 50 years in Springfield, and had carried on his work as a contractor during 30 years of that time. Funeral services were held at Springfield, Sept. 17.

Charles Morton Emmons, M. Am. Soc. C. E., of Beaver Falls, Pa., died Sept. 14 at a hospital in New Brighton, Pa., aged 46 years. He was a graduate of the engineering department of Cornell University in the class of 1888, and from 1888 to 1893 he worked as a draftsman for the Penn Bridge Co., at Beaver Falls. In 1893 he entered the service of the U. S. Engineer Corps as an inspector in the Buffalo District, and from 1897 to 1901 he was a U. S. Assistant Engineer. In 1901 Mr. Emmons returned to the Penn Bridge Co., and in the following year was made Chief Designer of that company, a position which he held until the time of his death.

R. E. Johnson, a civil engineer of San Francisco, Cal., died suddenly Sept. 6, of heart failure while at work on a reclamation project near Sonoma. Mr. Johnson was born in Pennsylvania 56 years ago, and after graduation at a technical school went to Brazil in 1878 with that ill-fated expedition which set out with the purpose of constructing a railroad around the falls of the upper Madera River, in order to establish direct communication between the United States and the interior of Bolivia. The project failed, and out of a total of 941 persons sent from the United States, 224 perished in about six months by shipwreck, fevers, and at the hands of savages. After returning to the United States and recovering from the fever, which had so emaciated him that he was not recognized by his family on arrival, he was engaged successively by the Pennsylvania, Chicago & Northwestern, Chicago, Burlington & Quincy, and the Union Pacific Rys. He retired from railroad work in 1891, and established in San Francisco a private practice, principally in reclamation work and hydraulics, which he followed actively to the very last hour of his life. Funeral services will be held at his old home in West Chester, Penn., where his remains were shipped Saturday morning, Sept. 9, for burial.—[Obituary by W. A. Cooper, Mills Bldg., San Francisco, Cal.]

Engineering Societies.

COMING MEETINGS.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-28. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-28. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10-17. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at St. Louis, Mo. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Oct. 24-28. Annual session at Chi... Ill. Secy., J. F. Calbreath, Denver, Col...

NATIONAL SOCIETY FOR THE P... MOTION OF INDUSTRIAL EDUCATION.
Nov. 2-4. Annual meeting at ...nati, Ohio. Secy., Edward H. Reisner, 20... st 44th St., New York City.

NATIONAL MUNICIPAL LEAGUE.
Nov. 13-16. Annual meeting at ...hmond, Va. Secy., Clinton R. Woodruff, 70... orth American Bldg., Philadelphia, Pa.

AMERICAN ROADBUILDERS' ASS...LIATION.
Nov. 14-17. Annual convention at ...ochester, N. Y. Secy., E. L. Powers, 150 N...au St., New York City.

AMERICAN RAILWAY ASSOCIATION.
Nov. 15. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church ..., New York City.

NATIONAL FOUNDERS' ASSOCIATION.
Nov. 15-16. Annual convention at New York City. Secy., F. W. Hutchings, ... Hammond Bldg., Detroit, Mich.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting at New York City. Acting Secy., D. H. Cox, 29 West 39th St., New York City.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 17-18. Annual meeting at Canton, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

Engineers' Club of St. Louis.

At the regular meeting of Sept. 26, Mr. Hiram Phillips presented an illustrated paper on the "Colorado Springs Water-Works."

American Road Builders' Association.

The annual convention will be held at Rochester, N. Y., Nov. 14-17. There will be an exhibition of road-building machinery and materials.

Western Railway Club.

At the regular meeting in Chicago, Sept. 19, a paper entitled "Some Experiments With Trucks" was presented by Mr. Geo. G. Floyd, Chief Mechanical Engineer of the American Steel Foundries.

Society of Automobile Engineers.

The annual meeting will be held in New York City, Jan. 18-20. This will be during the Commercial Vehicle Division of the Automobile Show at Madison Square Garden. The members of the Society will take part in a trip to Europe during November, 1911, leaving New York City about Nov. 1. The first few days in England will be spent at the Automobile Show, which will then be in progress in London. The Society will be entertained by the Institution of Automobile Engineers. Visits of inspection will be made to various automobile factories and to the Brooklands race track. A short trip will be made to France to visit automobile factories there.

The membership of the Society has increased from 300 in May, 1910, to a present total of 934.

American Institute of Mining Engineers.

A meeting of the New York section will be held at the Engineering Societies Building, in New York City, Sept. 22, at 8.30 p. m. Mr. Chas. P. Perin, Consulting Engineer of the Tata Iron & Steel Co., of Sakchi, Bengal, will deliver an illustrated lecture on the "Iron and Steel Industry of Japan."

Maintenance of Way Master Painters' Association.

The eighth annual convention will be held at Pittsburgh, Oct. 17-19. The program includes the following papers: President's Address, J. S. Rice; "When to Paint," Geo. Heinz; "Handling Waste Material," J. A. Hogg and J. Grimstead; "Brushes," H. M. Baxter; "Handling Supplies on Electric Lines," J. R. Shean; "Winter Work and Organization," J. A. Johanson and L. H. Francke; "Passenger Stations and the Traveling Public," Edward Hurst Brown.

American Mining Congress.

The date of the 14th annual session has been changed from Sept. 26-29 to Oct. 24-28. The convention will be held at the Hotel La Salle, Chicago, Ill. The change of date was made necessary to suit the convenience of President Taft, Dr. Holmes, Director of the Bureau of Mines, and other important speakers. Dr. Holmes will give an illustrated address on "Coal Problems," and Mr. Martin D. Foster, Chairman of the Committee on Mines and Mining of the House of Representatives, will talk on "The Relation of Congress to the Mining Industry." Mr. B. F. Bush, President of the Missouri Pacific Ry., will present a statement in regard to the present conditions of the coal industry. Among the general subjects to be considered at the convention are the following: The prevention of mining accidents; workmen's compensation for the victims of mining accidents; the prevention of waste of the natural resources and the conservation of the energy required for coal production; the public-lands question of the West.